SEPT 1977

practical WIRELESS

85

THE PW 'jubilee'

ELECTRONIC ORGAN
Part-1

Australia 85c
New Zealand 85c
South Africa 80c
Malaysia $2·25

Also:

C CAR VOLTAGE REGULATOR

GP SHORT-WAVE RECEIVER-1

New eries { DESIGN YOUR OWN PROJECTS
PASSING THE RADIO AMATEURS EXAM.

T.T.L. 74 I.C's By TEXAS, NATIONAL, I.T.T., FAIRCHILD Etc

7400	14p	7413	35p	7432	25p	7454	15p	7490	35p	74121	25p	74139	100p	74156	70p
7401	16p	7414	80p	7437	55p	7460	15p	7491	75p	74122	45p	74140	60p	74157	70p
7402	16p	7416	39p	7438	25p	7470	39p	7492	45p	74123	60p	74141	270p	74160	90p
7403	16p	7417	39p	7440	15p	7472	25p	7493	40p	74125	50p	74142	270p	74161	90p
7404	16p	7420	15p	7441	65p	7473	30p	7495	60p	74126	59p	74144	270p	74162	90p
7405	16p	7422	39p	7442	65p	7474	38p	7496	70p	74130	130p	74147	230p	74163	90p
7406	40p	7423	25p	7445	80p	7475	39p	74100	95p	74131	100p	74148	155p	74164	125p
7407	40p	7425	25p	7447	75p	7476	39p	74101	45p	74132	70p	74150	120p	74165	125p
7408	20p	7426	25p	7448	75p	7483	85p	74105	40p	74135	100p	74151	65p	74166	125p
7409	20p	7427	25p	7450	15p	7485	100p	74106	50p	74136	70p	74153	65p	74167	150p
7410	15p	7428	45p	7451	15p	7486	30p	74107	35p	74137	140p	74154	120p	74170	200p
7411	20p	7430	15p	7453	15p	7489	250p	74120	90p	74138	125p	74155	70p	74173	150p
7412	20p														

74174	100p	74180	70p	74188	350p	74251	90p	74298	100p	74365	80p	74490	150p	74C151	150p
74175	75p	74181	350p	74189	350p	74253	90p	74299	250p	74366	80p	74491	150p	74C154	350p
74176	100p	74182	90p	74190	140p	74256	90p	74300	250p	74367	80p	74492	150p	74C157	150p
74177	100p	74184	150p	74191	140p	74257	90p	74301	90p	74368	80p	74495	150p	74C160	150p
74178	140p	74185	150p	74192	120p	74259	250p	74302	90p	74369	80p	74496	150p	74C161	150p
74179	140p	74186	350p	74193	120p	74260	90p	74303	90p	74370	80p	74500	150p	74C162	150p
74180	100p	74187	350p	74194	140p	74265	90p	74304	90p	74371	80p	74501	150p	74C163	150p
74181	125p	74188	350p	74195	120p	74266	90p	74305	90p	74372	80p	74502	150p	74C164	150p
74182	75p	74189	350p	74196	140p	74267	90p	74306	90p	74373	80p	74503	150p	74C165	150p
74183	150p	74190	140p	74197	100p	74268	90p	74307	90p	74374	80p	74504	150p	74C173	150p
74184	150p	74191	140p	74198	185p	74273	90p	74308	90p	74375	80p	74505	150p	74C174	150p
74185	150p	74192	140p	74199	185p	74274	90p	74309	90p	74376	80p	74506	150p	74C175	150p
74186	350p	74193	140p			74276	90p	74310	90p	74377	80p	74507	150p	74C192	150p
74187	350p	74194	140p			74278	90p	74311	90p	74378	80p	74508	150p	74C193	150p
74188	350p	74195	140p			74279	90p	74312	90p	74379	80p	74509	150p	74C195	150p
74189	350p	74196	140p			74283	90p	74313	90p	74380	80p	74510	150p	74C200	150p
74190	140p	74197	140p			74284	90p	74314	90p	74381	80p	74511	150p	74C221	150p
74191	140p	74198	185p			74285	90p	74315	90p	74382	80p	74512	150p	74C240	150p
74192	120p	74199	185p			74286	90p	74316	90p	74383	80p	74513	150p	74C241	150p
74193	140p					74290	90p	74317	90p	74384	80p	74514	150p	74C242	150p
74194	140p					74293	90p	74318	90p	74385	80p	74515	150p	74C243	150p
74195	120p					74294	90p	74319	90p	74386	80p	74516	150p	74C244	150p
74196	140p					74295	90p	74320	90p	74387	80p	74517	150p	74C245	150p
74197	140p					74296	90p	74321	90p	74388	80p	74518	150p	74C247	150p
74198	185p					74297	90p	74322	90p	74389	80p	74519	150p	74C248	150p
74199	185p					74298	100p	74323	90p	74390	80p	74520	150p	74C249	150p
						74299	250p	74324	90p	74391	80p	74521	150p	74C250	150p
						74300	250p	74325	90p	74392	80p	74522	150p	74C251	150p
						74301	90p	74326	90p	74393	80p	74523	150p	74C253	150p
						74302	90p	74327	90p	74394	80p	74524	150p	74C256	150p
						74303	90p	74328	90p	74395	80p	74525	150p	74C257	150p
						74304	90p	74329	90p	74396	80p	74526	150p	74C258	150p
						74305	90p	74330	90p	74397	80p	74527	150p	74C259	150p
						74306	90p	74331	90p	74398	80p	74528	150p	74C260	150p
						74307	90p	74332	90p	74399	80p	74529	150p	74C261	150p
						74308	90p	74333	90p	74400	80p	74530	150p	74C262	150p
						74309	90p	74334	90p	74401	80p	74531	150p	74C263	150p
						74310	90p	74335	90p	74402	80p	74532	150p	74C264	150p
						74311	90p	74336	90p	74403	80p	74533	150p	74C265	150p
						74312	90p	74337	90p	74404	80p	74534	150p	74C266	150p
						74313	90p	74338	90p	74405	80p	74535	150p	74C267	150p
						74314	90p	74339	90p	74406	80p	74536	150p	74C268	150p
						74315	90p	74340	90p	74407	80p	74537	150p	74C269	150p
						74316	90p	74341	90p	74408	80p	74538	150p	74C270	150p
						74317	90p	74342	90p	74409	80p	74539	150p	74C271	150p
						74318	90p	74343	90p	74410	80p	74540	150p	74C272	150p
						74319	90p	74344	90p	74411	80p	74541	150p	74C273	150p
						74320	90p	74345	90p	74412	80p	74542	150p	74C274	150p
						74321	90p	74346	90p	74413	80p	74543	150p	74C275	150p
						74322	90p	74347	90p	74414	80p	74544	150p	74C276	150p
						74323	90p	74348	90p	74415	80p	74545	150p	74C277	150p
						74324	90p	74349	90p	74416	80p	74546	150p	74C278	150p
						74325	90p	74350	90p	74417	80p	74547	150p	74C279	150p
						74326	90p	74351	90p	74418	80p	74548	150p	74C280	150p
						74327	90p	74352	90p	74419	80p	74549	150p	74C281	150p
						74328	90p	74353	90p	74420	80p	74550	150p	74C282	150p
						74329	90p	74354	90p	74421	80p	74551	150p	74C283	150p
						74330	90p	74355	90p	74422	80p	74552	150p	74C284	150p
						74331	90p	74356	90p	74423	80p	74553	150p	74C285	150p
						74332	90p	74357	90p	74424	80p	74554	150p	74C286	150p
						74333	90p	74358	90p	74425	80p	74555	150p	74C287	150p
						74334	90p	74359	90p	74426	80p	74556	150p	74C288	150p
						74335	90p	74360	90p	74427	80p	74557	150p	74C289	150p
						74336	90p	74361	90p	74428	80p	74558	150p	74C290	150p
						74337	90p	74362	90p	74429	80p	74559	150p	74C291	150p
						74338	90p	74363	90p	74430	80p	74560	150p	74C292	150p
						74339	90p	74364	90p	74431	80p	74561	150p	74C293	150p

SEMICONDUCTORS
by MULLARD, TEXAS, MOTOROLA, SIEMENS, I.T.T., R.C.A.

AA113	18p	BA138	16p	BC168B	14p	BC548C	14p	BF123	45p	BF336	35p	BY164	50p	OC140	150p
AA144	18p	BA148	16p	BC168C	14p	BC549B	13p	BF125	45p	BF337	35p	BY404	30p	OC171	60p
AA217	38p	BA154	12p	BC169C	15p	BC549C	14p	BF127	50p	BF353	50p	C1120	38p	OC200	80p
AC125	38p	BA157	15p	BC171	14p	BC557	13p	BF128	50p	BF394	50p	C1124	38p	OC201	80p
AC126	19p	BA173	15p	BC172C	12p	BC558	13p	BF152	50p	BF451	50p	E300	42p	R1039	150p
AC127	19p	BA182	15p	BC182	12p	BC559	13p	BF154	50p	BF459	50p	E304	42p	TIP29	45p
AC127/01	25p	BA218	15p	BC182B	12p	BCY71	28p	BF167	35p	BF833	130p	E310	125p	TIP29A	47p
AC128	18p	BAX13	5p	BC182L	12p	BCY72	15p	BF179C	40p	BFX84	25p	E320	95p	TIP29B	49p
AC128	18p	BAX16	5p	BC183	12p	BD124	85p	BF180	39p	BFX85	30p	MJE340	45p	TIP29C	52p
AC153K	40p	BB105A	35p	BC183L	12p	BD131	85p	BF181	35p	BFX87	25p	MPSA06	35p	TIP30	55p
AC176	28p	BB110	45p	BC184	12p	BD132	85p	BF182	39p	BFX88	25p	OA10	49p	TIP30A	58p
AC177	35p	BC107	16p	BC184L	12p	BD135	49p	BF183	39p	BFY50	25p	OA47	15p	TIP30B	65p
AC191	38p	BC108	14p	BC186	25p	BD136	49p	BF184	35p	BFY51	25p	OA90	6p	TIP30C	70p
AD149	60p	BC108C	15p	BC205	14p	BD137	49p	BF185	35p	BFY52	25p	OA91	6p	TIP31	55p
AD161	48p	BC109	16p	BC212	12p	BD138	49p	BF194	10p	BFY90	125p	OA202	8p	TIP31A	58p
AD162	48p	BC109C	14p	BC212L	12p	BD139	49p	BF195	10p	BFY90	125p	OC23	200p	TIP31B	65p
AD161/2MP	pr	BC113	12p	BC213L	12p	BD140	49p	BF196	10p	BR101		OC25	100p	TIP31C	70p
	90p	BC117	19p	BC214	13p	BD175	40p	BF197	10p	BRY56		OC26	100p	TIP32	60p
AF114	50p	BC125	25p	BC214L	13p	BD176	40p	BF198	25p	BRY56		OC35	75p	TIP32A	65p
AF115	22p	BC126	15p	BC258	13p	BD177	40p	BF199	30p	BSX20		OC42	75p	TIP32B	85p
AF116	22p	BC146	12p	BC294	45p	BD178	40p	BF200	39p	BSY40		OC43	35p	TIP32C	90p
AF117	22p	BC147	10p	BC303	55p	BD182	80p	BF224	25p	BSY51		OC45	35p	TIP33A	90p
AF118	36p	BC148	10p	BC307	10p	BD183	80p	BF225	39p	BT100A		OC71	25p	TIP33B	95p
AF125	25p	BC148C	14p	BC323	60p	BD233	59p	BF244B	35p	BU105		OC72	25p	TIP33C	100p
AF126	25p	BC149	10p	BC328	60p	BD234	65p	BF245	35p	BU133		OC74	30p	TIP34A	95p
AF127	25p	BC157	16p	BC338	12p	BD410	100p	BF256	39p	BU208		OC75	30p	TIP34B	100p
AF239	45p	BC158	16p	BC477	15p	BDY92/01	150p	BF258	39p	BY100		OC81	35p	TIP34C	105p
BA114	18p	BC159	16p	BC478	25p	BF115	45p	BF259	39p	BY126		OC81D	25p	TIP41A	90p
BA121	9p	BC167A	12p	BC548	12p	BF121	45p	BF324	30p	BY133		OC82	35p	TIP41B	95p
												OC84	50p	TIP41C	100p
														TIP42A	95p
														TIP42B	100p
														TIP42C	105p
														TIP55	70p
														TIP120	150p
														TIP121	150p
														TIP122	150p
														TIP125	150p
														TIP2955	150p
														TIP3055	70p
														TIS90	25p
														TIS91	25p
														TIS97	25p
														2N1302	110p
														2N1303	70p
														2N1304	70p
														2N1305	70p
														2N1306	70p
														2N1307	70p
														2N1308	70p
														2N1711	25p
														2N2219A	25p
														2N2222	18p
														2N2222A	20p
														2N2907	35p
														2N3053	25p
														2N3054	50p
														2N3055	60p
														2N3439	90p
														2N3702	11p
														2N3703	12p
														2N3704	11p
														2N3705	12p
														2N3706	11p
														2N3711	12p
														2N3771	230p
														2N3772	175p
														2N3819	45p
														2N3866	95p
														2N4058	11p
														2N4062	14p
														2N4286	14p
														2N5061	35p
														2N5062	35p
														2N5457	58p
														2SD234	56p

BZY88		CA3090AQ	400p	**ELECTROLYTIC CAPACITORS**			330/35	16p	**SPECIAL OFFERS**		**RESISTORS**		**MULLARD POT CORES**		**SKELETON PRE-SET POTENTIOMETERS**
400M.W.				µF/V			330/50	18p			**CARBON FILM** 5%		LA3	100–500 KHz	75p	
Zeners		TAA300	150p	1/16	5p		470/10	12p	25 W				LA4	10–100 KHz	100p	
2V7	10p	TAA350	180p	1/16	5p		470/16	12p	2 Ω 0.4 7M	2p			LA5	30–100KHz	100p	
3V0	10p	TAA550	50p	1/10	5p		470/25	15p			5 W		LA7	455K Hz	60p	
3V3	10p	TAA611B	140p	1/50	5p		470/35	18p	2 Ω 12-4 7M	2.5p	2 Ω 10 MEG	3.5p	LA13 FOR W.W. OSCILLOSCOPE		200p	
3V6	10p	TAA700	280p	2/25	5p		1000/10	25p								
3V9	10p	TAD100	250p	2/35	5p		1000/16	25p	2 Ω 12-4 7M	2.5p						
4V7	10p	TBA120S	125p	4/10	5p		1000/35	30p	2 Ω 10 MEG	3.5p						
5V1	10p	TBA120T	125p	4/25	5p		1000/50	50p								
5V6	10p	TBA540	300p	4/35	5p		2200/10	28p								
6V2	10p	TBA540Q	400p	4/50	5p		2200/35	35p								
6V8	10p	TBA550Q	400p	6.8/25	5p		2200/16	35p								
7V5	10p	TBA560	350p	10/10	5p		2200/50	70p								
8V2	10p	TBA641A12	250p	10/16	5p		2200/100	100p								
9V1	10p	TBA720	250p	10/25	5p		3300/16	35p								
10V	10p	TBA800	100p	10/50	5p		3300/25	42p								
11V	10p	TBA920	150p	22/10	5p		3300/63	85p								
BZY88		TBA990	250p	22/16	5p		4700/25	45p								
12V	10p	TCA270Q	250p	22/25	5p		4700/40	50p								
13V	10p	TCA270S	250p	22/25	5p		4700/63	120p								
15V	10p			47/10	5p											
18V	10p	LM301A	65p	22/50	5p		**POLYTER CAPACITORS**		**RELAYS**							
20V	10p	LM307A	65p	33/16	5p		Mullard or Erie		24V 3 C.O. H.D.							
22V	10p	LM308 D.I.L.	130p	33/16	5p		µF/V		11 Pin Plug 1N							
24V	10p	LM309 K	180p	33/25	5p		.001	5p	**£1·00 Each**							
30V	10p	LM309H	185p	33/40	5p		.0022	5p								
33V	10p	LM340T	280p	47/10	5p		.005	5p	**ASSORTED POLYESTER CAPACITORS**							
100 Mixed		LM380N	110p	47/10	5p		.0033	5p								
Zeners **85p**		LM555	75p	47/25	5p		.0047	5p								
BZY88		LM710 TO5	60p	47/25	5p		.0068	5p	**100 for £5·00**							
Zeners **85p**		LM710 P	45p	47/35	5p		.01	5p								
		LM723 TO5	60p	47/50	7p		.022	5p								
SAD1024	1250p	LM723 14 DIL	70p	100/10	5p		.033	5p	**BYX84 DIODES**							
5N7603ND	125p	LM741	25p	100/16	6p		.047	5p	1250 PIV 1 Amp.							
5N7602ND	125p	LM748	45p	100/25	6p		.1	5p	**100 for £8·00**							
5N7603N	125p	LM833N	155p	100/50	6p		.22	8p								
5N7602TN	150p	LM3900	90p	100/63	8p		.33	8p	**MULLARD**							
5N7602BR	188p			220/16	8p		.47	15p	1P 10V	48p						
5N7666N	160p	NE555	35p	220/16	10p		1·00	25p	4500/64V C.432	48p						
2N414	12p	NE556	100p	220/25	8p		2·2	25p	Screw Terminal	48p						
2N414	12p	NE560B	600p	330/25	15p		4·7	35p		75p						
							6·8	40p	3P 4W	48p						
									4P 3W	48p						
									4P 3W	48p						

SPECIAL OFFERS	
BC147	10p
BC148	10p
BC149	10p
BC157	10p
BC158	10p
BC159	10p
BF194	10p
BF195	10p
BF196	10p
BF197	10p
IN4148	
100 for 150p	
741 Op AMPS	
100 for £20	
555 TIMERS	
100 for £30	
RELAYS	
24V 3 C.O. H.D.	
11 Pin Plug 1N	
£1·00 Each	
ASSORTED POLYESTER CAPACITORS	
100 for £3·00	
BYX84 DIODES	
1250 PIV 1 Amp.	
100 for £8·00	
MULLARD	
4500/64V C.432	
Screw Terminal	75p

ASSOR-TED FOR £7·50p

POTENTIO-METERS

1K Lin	39p
5K Lin	39p
10K Lin	39p
25K Lin	39p
50K Lin	39p
100K Lin	39p
250K Lin	39p
500K Lin	39p
1 Meg Lin	39p
2 Meg Lin	39p
5K Log	39p
10K Log	39p
25K Log	39p
50K Log	39p
100K Log	39p
250K Log	39p
500K Log	39p
1 Meg Log	39p
2 Meg Log	39p

ROTARY SWITCHES BY LORLIN

1P 12W	48p
2P 8W	48p
3P 4W	48p
4P 3W	48p

SPECIAL SOOP OFFERS

SEMICONDUCTORS. ALL BRANDED NAMES E.G. MULLARD, TEXAS, SIEMENS, VALVO. BC107B, BC108B, BC108C, BC109B, BC109C.

£8 · 50 PER 100 CAN BE ASSORTED

WESTINGHOUSE THYRISTORS

300 Volts	16 Amp	250p

CMOS

4000	30p	4023	20p	4055
4001	20p	4024	100p	4056
4002	20p	4025	20p	4060
4006	120p	4026	280p	4066
4007	20p	4027	85p	
4009	75p	4028	155p	4069
4011	20p	4029	180p	4071
4012	20p	4030	60p	4072
4013	60p	4035	150p	4081
4015	90p	4043	220p	4082
4016	55p	4044	220p	4510
4017	110p	4047	150p	4511
4018	140p	4049	70p	4516
4020	140p	4050	50p	4518
4022	180p	4054	130p	4528

70p	74174	100p	74C151	150p	74C221	150p	74C285
70p	74175	75p	74C154	350p	74C240	150p	74C286
90p	74176	100p	74C157	150p	74C241	150p	74C287
90p	74177	100p	74C160	150p	74C242	150p	74C288
90p	74178	140p	74C161	150p	74C243	150p	74C289
90p	74179	140p	74C162	150p	74C244	150p	74C290
125p	74180	100p	74C163	150p	74C245	150p	74C291
125p	74181	350p	74C164	150p	74C247	150p	74C292
125p	74182	75p	74C165	150p	74C248	150p	74C293
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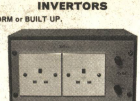

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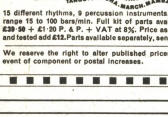


15 different rhythms, 9 percussion instruments. Tempo range 15 to 100 bars/min. Full kit of parts available at £39·90 + £1·20 P. & P. + VAT at 8%. Price assembled and tested add £12. Parts available separately, send S.A.E.

We reserve the right to alter published prices in the event of component or postal increases.

P.E. ORION STEREO AMPLIFIER & TUNER

May be mounted slim line or stacked as above. Parts available separately for both units.

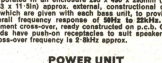
20 + 20 Watts r.m.s. into 2 ohm load. Distortion less than 0·1% 100Hz–10kHz. Frequency response ± 1dB 20 Hz to 25kHz. Hum level virtually nil with volume full on. This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc, tape, tuner, etc.

TUNER UNIT

May be purchased separately in matching slim line case. As full kit or individual parts.

Send S.A.E. for price list and specification sheets.

LOUDSPEAKERS



8 inch system

This system is designed for use with above amplifiers rated up to 25W r.m.s. per channel at 8 Ω. May be incorporated in an enclosure 295 x 490 x 295mm (11·5 x 19·3 x 11·8in) approx. external, constructional details of which are given with each bass unit, to provide an overall frequency response of 50Hz to 25kHz. Four-element cross-over, ready constructed on p.c.b. Output leads have push-on receptacles to suit speaker tags. Cross-over frequency is 2·8kHz approx.

POWER UNIT

Regulated

Voltage adjustable from 1–35v at 2 amps. Short circuit protected. Voltage and current meters incorporated. Full Kit of parts £48 + 8% VAT or assembled and tested £58 + 8% VAT.

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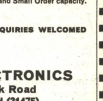

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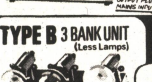

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Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two task-simulate enclosures, two EMI 13" × 8" (approx.) woofers, two tweeters and a pair of matching crossovers. Easily constructed, using a few basic tools. Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms. 30 watts peak. unit. Cabinet size 20" × 11" × 8½" (approx.).

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Ideally suited for the constructor who requires a complete stereo unit at a budget price, comprising ready assembled stereo amp. module, Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phones socket and record / replay socket

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Complete with speaker, baffle and fixing strip. The Tourist IV for the experienced constructor only. The Tourist IV has five push buttons, four medium band and one for long wave band. The tuning scale is illuminated and attractive small aluminium control knobs are used for manual tuning and volume control. The modern style fascia has been designed to blend with most car interiors and the finished radio will slot into a standard car radio aperture.

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Viscount IV 20 x 20 Amplifier as illustrated, plus 1 pair of speakers finished in teak with melamine panels 8" drive unit and 3½" square tweeter. 22" × 13" × 10½" size approx.

£45.00

SPECIAL OFFER

illustrated **20 x 20 WATT STEREO AMPLIFIER**

Superb Viscount IV unit in teak-finished cabinet. Silver fascia with aluminium, rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic. magnetic and crystal pick-ups, tape, tuner, and auxiliary Rear panel features two mains outlets. DIN speaker and input sockets, plus fuse. 20 + 20 watts rms, 40 + 40 watts peak.

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FREE "Limited Period" A Free 4 Channel Stereo Adaptor to all purchasers of the Viscount Amplifier. Available separately. **£3.95** + p & p £1.00

SPECIAL OFFER for example, Duo Speaker system II or II Viscount Amplifier, MP60 type turntable complete

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BSR MP60 TYPE
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TURNTABLE illus. Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover. Ready wired

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30 x 30 WATT AMPLIFIER KIT

Specially designed by RT-VC for the experienced constructor, this kit comes complete in every detail. Some facilities as Viscount IV amplifier. Chassis is ready punched, drilled and formed Cabinet is finished in teak veneer, Silver fascia and easy-to-handle aluminium knobs.

Output 30 + 30 watts rms, 60+60 peak. **£29.00** + p & p £2.10

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£27.50 + p & p £2.50

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Here's the mono unit you need to start off with. Gives you a good solid 35 watts rms, 70 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

100 WATT MONO DISCO AMP

Size approx. 14" × 4" × 10½".

Sloping facia,you can use the controls without fuss or bother. Brushed aluminium fascia and rotary controls. Five smooth acting, vertically mounted slide controls – master volume, tape level, mic level, deck level, PLUS INTER-DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading **£65.00**

it in. VU meter monitors output level.

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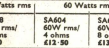

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As with the mixers the MK II L.C. unit may be purchased in module form with all controls, requiring only a panel, case & knobs etc. There are 13 simple connections.

- 1-240w Audio
- 8A RCA trixes
- 0·5-20Hz Sequence
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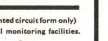
Make your own mixer, mono or stereo, up to 2 channels, with full monitoring facilities. and provision for echos end/return etc.



- Inputs for low and high 2 mic, ceramic & magnetic cartridge etc.
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Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

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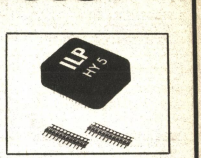

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APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
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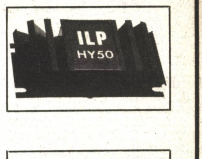

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FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

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SUPPLY VOLTAGE ± 25V SIZE 100 50 25mm

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HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm

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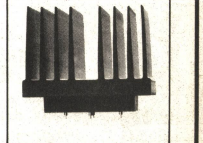

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink —No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm

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HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω ! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power modular module.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz.
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm

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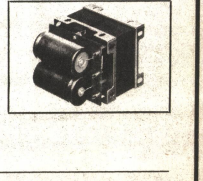

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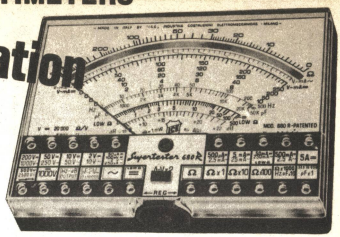

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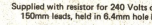

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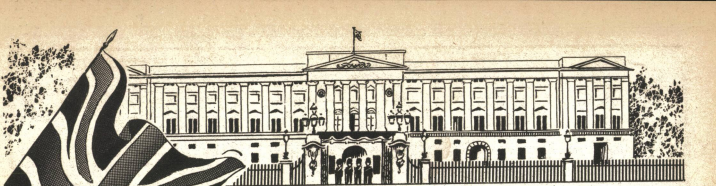

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7405	0·11	0·10	74S05	0·12	0·10
7406	0·28	0·25	74S10	0·24	0·23
7407	0·28	0·25	74S11	0·24	0·23
7408	0·13	0·11	74S13	0·24	0·22
7409	0·12	0·11	74S14	0·24	0·23
7410	0·09	0·08	74S15	0·24	0·23
7411	0·23	0·20	74S16	0·24	0·23
7412	0·23	0·20	74S20	0·24	0·23
7413	0·26	0·25	74S21	0·24	0·23
7416	0·28	0·25	74S22	0·24	0·23
7417	0·26	0·25	74S30	0·24	0·23
7420	0·11	0·10	74S40	0·85	0·80
7423	0·19	0·18	74S50	0·12	0·10
7423	0·21	0·20	74S86	0·28	0·26
7425	0·28	0·23	74S89	2·70	2·50
7426	0·25	0·23	74S90	0·38	0·32
7427	0·25	0·23	74S91	0·65	0·62
7428	0·36	0·34	74S92	0·43	0·35
7430	0·12	0·10	74S93	0·38	0·35
7432	0·20	0·19	74S94	0·70	0·68
7433	0·38	0·36	74S95	0·60	0·58
7437	0·26	0·25	74S96	0·70	0·68
7438	0·26	0·25	74S100	0·95	0·90
7440	0·12	0·10	74S104	0·90	0·85
7441	0·60	0·57	74S105	0·90	0·85
7442	0·80	0·70	74S107	0·30	0·25
7443	0·95	0·90	74S110	0·48	0·45
7444	0·95	0·90	74S111	0·75	0·72
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BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

Our Face-lift

Well, here it is! The new and, we hope, more attractive, larger version of **Practical Wireless**, as promised last month. PW has gone through other changes of size in the 45 years that it has been around and when it was first published in 1932 the page size was just the same as our 'new' format! So we seem to have gone through the whole cycle! In the 60's PW was quite small, about 9 × 6in., with correspondingly more pages but it was quite popular since one could roll or fold it up to fit the coat pocket, and I would imagine that there are many readers who would still prefer it that way!

Those that know all about these things have now been able to produce a bigger page area from the same size reel of paper, although the printing costs are marginally higher. We trust that you will like the slightly larger type face, being easier to read. Anyway, if you do favour the new-look **Practical Wireless** do not hesitate to let us know. No doubt the disapprovers will also be in touch but their letters will be equally welcome.

As the compiler of the amateur bands section of our monthly feature "On the Air" I know something of the problems that can be encountered by the very keen listener to the amateur bands who wants to get on and obtain the amateur transmitting licence. Although many schools, colleges and radio clubs run classes for the Radio Amateur's Examination there are many potential candidates who just cannot reach such places and who must rely on their own studies at home.

This month sees the start of a new series aimed not only at the the person who, perforce, has to be a loner, but all those who aspire to the RAE. Remember, it is unlikely that any two candidates will be starting from precisely the same level. There is the newcomer to electronics, who, by sheer enthusiasm, will spend every possible moment studying both the theoretical and practical side of our hobby, and there is the electronic engineer, with degrees after his name, who needs to swot up on certain aspects of the subject before sending in the rather exhorbitant entrance fee. Today, it behoves every candidate for the RAE to be really sure that he is prepared for the exam. Whatever his capabilities may be on the technical side he must still swot up on the legislation governing the issue of an amateur licence. Part 1 of the exam is not in the least difficult but a failure in this part means a failure of the whole paper, even if you are a veritable genius at electronics!

So we hope that our RAE course will help readers of all technical abilities and, probably, many other readers too, who may never have heard of the RAE!

Eric Dowdeswell *Assistant Editor*

PLEASE NOTE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.
All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

NEWS... NEWS... NEWS...

New catalogue

Bi-Pak has announced the publication of its latest catalogue containing over 120 pages of electronic component listings. There are numerous, albeit rather small, pictures and line drawings. The semiconductor section generally includes pinout details and limited operational parameters. The cost is 50p + 15p postage.

Bi-Pak Semiconductors, The Maltings, 63A High Street, Ware, Herts SG12 9AD.

Audio Fair '77

Don't forget that the Audio Fair '77 is coming shortly and promises to be the most comprehensive ever staged. Displays will range from the most sophisticated BBC/IBA/GPO Data transmission modes to the more mundane HiFi equipment, TV games and home movie apparatus.

The show which is at London's Olympia will open from 2pm-9pm on September 13th, from 10am to 9pm on September 14th, 15th, 16th and 17th, and from 10am to 8pm on Sunday, September 18th. Admission will be 70p for adults, and children under 14, 30p.

New distributor

Plessey Aerospace has appointed Sasco as sole stockist for their complete range of Plessey miniature relays. Products covered by this agreement include half-crystal-can and full-crystal-can types (sealed and unsealed), hermetically sealed 10A crystal-can versions, and rotary armature Type II relays.

Sasco, PO Box 2000, Crawley, Sussex.

New service

Audio Workshops Ltd., have now opened their new showroom at 33 London Road, Southborough, Tunbridge Wells, Kent, where they will be stocking a wide variety of FM aerials, aerial accessories, cables, rotators and electronic car aerials.

The showroom also displays a wide variety of aerial amplifiers from simple low-cost single transistor amplifiers to high quality semi-professional low noise masthead amplifiers.

Full advice as to which aerial or accessory should be purchased to obtain optimum performance will be available from the founder of Audio Workshops, Mr Peter Dunkley. And as a small incentive to go along and see what's available, the firm is offering a high quality 8 element FM aerial at £12·75—for a limited period.

A winner

Marshall's have produced a brand new catalogue in a much larger format than before, a bit bigger than this issue of PW. Many new lines include microprocessors and supporting devices, a range of Digital Multi Testers and a pull-out Transistor Guide for the shack wall. Cost is 25p to callers or 35p by post.

A Marshall (London) Ltd., 42 Cricklewood Broadway, London NW2 3ET.

Talking show

An exhibition to commemorate Thomas Edison's invention in 1877 of the Talking Machine is to be held in conjunction with the British Institute of Recorded Sound during August. Comprising some 125 exhibits, the theme of the displays will be the evolution of the phonograph and gramophone from the original hand turned models to today's HiFi. Early original records together with some interesting accessories complete the displays.

Spare parts manufactured by the organisers of the exhibition for collectors will also be available, as will reprints of early catalogues, posters and instruction manuals.

Called "100 years of Recorded Sound" the exhibition will be open to the public from Saturday 13th August to Saturday 27th August (excluding Mondays). Opening times will be 10am until 6pm.

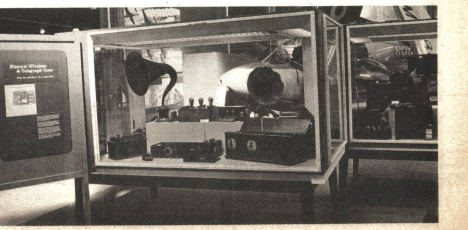
Further information from Goodwin Eve, City of London Phonograph & Gramophone Society, Farm Cottage, High Road, Chipstead, Surrey. Tel: 07375 54827.

Jermyn gen

Jermyn Distribution have now made available the new National Semiconductor MOS/LSI Databook. Containing 400 pages divided into 14 sections, this Databook lists details of electronic organ and TV circuits; A/D converters; communications/CB radio circuits; watches, calculators and keyboard encoders.

In each section, complete characteristics, connection details, function descriptions, and block diagrams are all covered, while the last chapter gives physical dimensions of all National Semiconductor products together with a definition of terms. Priced at £5·95, it can be obtained from *Jermyn Distribution, Sevenoaks, Kent.*

Part of Ron Ham's early wireless collection which is on display at The Cornwall Aircraft Park, Helston, Cornwall until October 31st. Some of the items on exhibition were featured in *Practical Wireless*, September 76. On the left hand side of the show case is a copy of the article which was published in The Times newspaper, September 26, 1975 about the collector and his historic pieces. Ron is a very fervent supporter of the new industrial museum that is to be built at Houghton in Sussex and which, he expects, will be the permanent home of his collection that dates back to 1900.



So you want to pass the R.A.E. (Radio Amateurs' Examination)?

No. 1

John Thornton Lawrence GW3JGA & Ken Mc Coy GW8CMY

The passing of the Radio Amateurs' Examination, set by the City and Guilds, requires a certain level of theoretical technical knowledge. Whether one considers that this level is too high or too low is beside the point. The course that follows is intended, with the help of certain external aids, to prepare the reader to pass the examination. It will not teach him all about electronics!

The Radio Amateur is a privileged person indeed, he has access to various parts of the radio frequency spectrum which enable him to talk to other amateurs near to him or in any other part of the world. The Radio Amateur has his own international language, he belongs to a worldwide brotherhood of Radio Amateurs whose "Ham Spirit" takes no account of race, colour, political or social outlook. To ensure that these privileges are not abused, the Licensing Authority (the Home Office) require some test of the would-be amateur's technical competence and knowledge of the radio "Highway Code", before giving him a licence to drive on the frequency motorways of the world, in short, the Radio Amateurs' Examination.

ABOUT THE AUTHORS

John Thornton Lawrence. T.Eng. (C.E.I.), F.S.E.R.T., *is a Senior Scientific Officer concerned mainly with electronic instrumentation, measurements and calibration. He obtained his licence GW3JGA in 1953 and his amateur TV licence GW3JGA/T (later GW6JGA/T) in 1958. He is a Committee member of the British Amateur Television Club and a Founder of the University College of North Wales ARS.*

His hobbies include amateur VHF, UHF and TV equipment, collecting antique radio gear, particularly valves, wine and beer making and helping the local Scout Group. He is married with two sons, 19 and 9.

Ken McCoy *holds an HNC in Electrical and Electronic Engineering and is concerned with instrumentation and electron microscopy. He is a part-time lecturer for the Radio Amateur's Examination course at the Gwynedd Technical College.*

He obtained his licence GW8CMY in 1967 and his main interest is in building portable 2m equipment. His other hobbies include mountaineering in the UK and on the Continent, photography and DIY home improvements. He is a team leader in the Ogwen Valley Mountain Rescue Organisation. He is married with a son, 14, and two daughters, 12 and 6.

. . . 'writing to the City and Guilds'

Maybe you are one of those whose interest in Amateur Radio has been building up steadily for some time and the point has now been reached where you have to decide whether or not to enter for the R.A.E. If you are dithering on the brink, you may be interested to know that this is the first of a series of articles concerned with preparing for and successfully taking the Radio Amateurs' Examination. It is not intended to be a complete course leading up to the R.A.E. but more of a progressive clarification of some of the problem areas which can be the undoing of many candidates.

The main core of information is best obtained from books specially written for the Radio Amateur and for the R.A.E. in particular and these will be referred to from time to time. Practical work is an important part of preparing for the R.A.E. and suggestions for this will be included where necessary. If by now you have decided to proceed, then please read on.

Taking stock

We are very pleased to see that you have now made up your mind to have a go at the R.A.E. Before we do anything else, let's take stock of the situation. You say that you did the usual basic arithmetic in school (but that seems a while ago!) and you naturally feel a bit rusty in that area and with electrical theory, even more so. OK, so some work is definitely required to bring these up to scratch.

How about circuits? You're able to follow some of the simple circuits without much difficulty but find it quite a struggle to explain, in so many words, how they work. Well, perhaps this is just because you are not looking at them in the right way, so more about that later.

Now the practical side. You say that you have built up the odd electronic circuit from *PW* and have got it working OK, fine! By the way, do you go to the

local Amateur Radio Club meetings? No? Pity! You see, it's very helpful if you can do some practical work in connection with the R.A.E. and membership of the local Radio Club is very useful in this respect as it will give you the chance to see amateur radio equipment being used and to obtain some guidance and help when you are building things for yourself. Write to the R.S.G.B. for details of your local club as many clubs are affiliated to the R.S.G.B.

Preparations

You will need to get some books and information on the examination, past R.A.E. papers and so on. These take a little time to come so I suggest that you order these now. First write to: The City and Guilds of London Institute, 76 Portland Place, London W1N 4AA, for Pamphlet 765 Radio Amateur's Examination 1976-1978, including a set of Question Papers for the last three years. Remember to enclose a cheque or P.O. for 40p. This represents very good value, as usually each set of City and Guilds Question Papers is extra.

The Home Office publishes a useful document about becoming a Radio Amateur and this is available free of charge. Write to: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, Waterloo Road, London SE1 8UA, for leaflet "How to become a Radio Amateur".

Now, moving on to textbooks and booklets, these can be roughly divided into two categories, the essential, and the desirable but not essential. The essentials, which are all published by the Radio Society of Great Britain, can be obtained from your local bookshop (if you want to use up that birthday book token from auntie!) or, cash with order, from: R.S.G.B. Publications (Sales), 35 Doughty Street, London WC1N 2AE.

They are:

"A Guide to Amateur Radio" by Pat Hawker G3VA. £1·35.

"The Radio Amateurs' Examination Manual" by G. L. Benbow G3HA. £1·35.

"Radio Amateurs' Revision Notes" by G. L. Benbow G3HA. 61p.

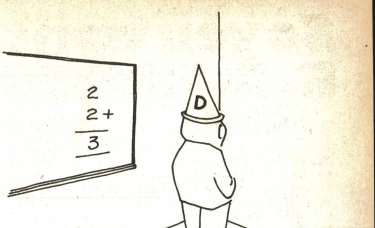
The books in the second category are much more comprehensive and naturally cost more. These are also available from R.S.G.B. Publications (Sales) but as an alternative to immediate purchase, they may be obtained from your local library. They are: Radio Communication Handbook (R.S.G.B.) 5th Edition Vols. 1 and 2, or Radio Amateurs' Handbook 1977 (A.R.R.L.).

Getting down to it

The method of studying for the R.A.E. depends on your personal circumstances. The various ways are:

(a) Evening classes.
(b) Correspondence course.
(c) Home study, with or without some tuition.

If you live near a technical college or school which runs evening classes, then this is probably the best way for you to study. A direct approach to the college or school will provide you with full details. Correspondence courses or home study for the R.A.E. require continuous and regular work sessions. Home study requires a lot more personal discipline to get through the more difficult items as you will find it a great temptation to leave them until the end, when it is usually too late!



. . . 'mathematics a bit rusty?'

It is always useful, and particularly so in the case of home study, if you can enlist the help of a local Radio Amateur or suitably qualified friend, who will talk-through any problems you may have.

Here we are then, you have registered at your local evening institute for the R.A.E. course, the books are ordered and you are ready and waiting to get down to the "nitty gritty".

Arithmetic

Let's start with arithmetic (we always think that the word arithmetic is less daunting than mathematics). There are going to be some calculation questions in the R.A.E. and if you can do these correctly, you can gain full marks on each question in a matter of minutes. Even fairly straightforward electrical calculations can present very real difficulties if you have not seen the sharp end of a blackboard pointer since you left school, so the purpose of this section is to remind you of the basics involved in these sums and to suggest a few tricks to make them easier to execute and remember.

If you have read through the instruction book of a pocket calculator you will know that there are four "basic arithmetical functions", namely, addition, subtraction, multiplication and division.

Addition and Subtraction—So far as the problems that you will meet in the R.A.E. are concerned, addition and subtraction will take care of themselves, for example, $3+7=10$ and $4-2=2$. Multiplication and division may be written down in several different ways, so here are a few alternatives.

Multiplication—$A \times B$ can also be written as A.B. or simply AB.

Division—$A \div B$ can also be written as $\frac{A}{B}$. Thus $1 \div 2$ is the same as $^1/_2$ ("one upon two" or "one over two").

Now for the not-so-basic arithmetic functions, reciprocals, squares and square roots.

Reciprocals—The reciprocal of A is $\frac{1}{A}$ or from division $1 \div A$ or "one upon A", and to put it numerically, the reciprocal of 4 is $^1/_4$ and of 100 is $\frac{1}{100}$.

This function, together with the squares and square roots, occurs often in resonance and frequency calculations.

Squares—If a number is multiplied by itself the answer is known as the square of the number. For example, $A \times A$ is written as A^2 or "A squared". Thus A^2 is the square of A. And, to put it numerically, 9 is the square of 3, since $3 \times 3 = 9$.

Square Roots—The square root of a number is a figure which, when multiplied by itself, is equal to the original number. For example, the square root of 9 is 3 because when 3 is multiplied by itself, it equals 9, written $\sqrt{9} = 3$ because $3 \times 3 = 9$. Similarly, $\sqrt{25} = 5$ (because $5 \times 5 = 25$) and $\sqrt{4}$ or "Root 4" $= 2$ ($2 \times 2 = 4$) and so on.

Incidentally, not all square roots are whole numbers. For instance, $\sqrt{2}$ has been calculated to at least 50 decimal places, but is used most often as 1·41. Finally, $\sqrt{2} \times \sqrt{2} = 2$ and $\sqrt{5} \times \sqrt{5} = 5$ and $\sqrt{25} \times \sqrt{25} = 25$.

Problems in the actual R.A.E., which involve finding the square roots of numbers, can be dealt with by looking up the value in the square root tables which are provided.

Multiples and sub-multiples

Some of the electrical units that are used in radio are inconveniently small for practical purposes and so a multiple of the unit is used. Some others, for example, the Henry and the Farad, are inconveniently large. A one Farad capacitor having a particular dielectric between its plates, might occupy a volume similar to that of a block of flats!

The capacitors and inductors used in radio work have values which are sub-multiples of the Farad and the Henry. You will, therefore, need to be able to recognise multiples and sub-multiples in words and in figures.

Multiples—Multiples are described by a prefix to the unit in question. For example, 1 Megohm = 1,000,000 ohms. A list of multiple prefixes is given below.

Prefix	Letter		Index Form
tera	T	one million million	10^{12}
giga	G	one thousand million	10^{9}
mega	M	one million	10^{6}
kilo	k	one thousand	10^{3}
hecto	h	one hundred	10^{2}

Sub-multiples—Sub-multiples are described by a letter prefix in a similar fashion. For example, 0·000,001 Farad = 1 microfarad = 1μF. A list of sub-multiple prefixes is given below.

Prefix	Letter		Index Form
deci	d	one tenth	10^{-1}
centi	c	one hundredth	10^{-2}
milli	m	one-thousandth	10^{-3}
micro	μ	one millionth	10^{-6}
nano	n	one thousand millionth	10^{-9}
pico (or $\mu\mu$)	p	one million millionth	10^{-12}

Indices

You will notice from the previous sections that the multiplier and sub-multiplier are written as a figure followed by or preceded by a number of noughts. This number, when expressed in what is known as "index form", uses a special notation which is best shown by example:

mega = 1,000,000 In index form 10^6
giga = 1,000,000,000 In index form 10^9

In the case of multiples, the index number is equal to the number of noughts following the figure, so that, for example:

2·2 Megohms is written as $2 \cdot 2 \times 10^6$
and 7·3 Gigahertz is written as $7 \cdot 3 \times 10^9$ Hertz.

Sub-multiples use the same notation but with a slight difference:

pico $= 0 \cdot 000,000,000,001 = 10^{-12}$
micro $= 0 \cdot 000,001 = 10^{-6}$

You will notice that in the case of sub-multiples, the index number is **minus** and equivalent to the **number of noughts** plus one following the decimal point. For example:

2·2 picofarads $= 2 \cdot 2 \times 10^{-12}$ Farads.
7·3 microhenrys $= 7 \cdot 3 \times 10^{-6}$ Henrys.

It is often desirable to convert from one multiple of an electrical unit to a different multiple and this can be done by moving the decimal point and at the same time changing the index number accordingly. For example:

$2 \cdot 2$ Megohms $= 2{,}200{,}000$ ohms
$= 220{,}000 \times 10$ ohms
$= 22{,}000 \times 10^2$
$= 2{,}200 \times 10^3$ ohms (kilohms)
$= 220 \times 10^4$ ohms
$= 22 \times 10^5$ ohms
$= 2 \cdot 2 \times 10^6$ ohms (Megohms)

Similarly,

$0 \cdot 000,000,002$ Farads $= 0 \cdot 002 \times 10^{-6}$ Farads
$= 0 \cdot 002$ microfarads (μF)
$= 2 \times 10^{-9}$ Farads
$= 2$ nanofarads (nF)
$= 2{,}000 \times 10^{-12}$ Farads
$= 2{,}000$ picofarads (pF)

Multiplying—When **multiplying** figures in index form it is only necessary to **add** the indices. For example:

$10^4 \times 10^6 = 10^{10}$
$10^4 \times 10^{-6} = 10^{-2}$
$10^{-4} \times 10^6 = 10^2$
$10^{-4} \times 10^{-6} = 10^{-10}$

Dividing—when **dividing** figures in index form it is only necessary to **subtract** the indices. For example:

$$\frac{10^6}{10^4} = 10^6 \div 10^4 = 10^2$$

$$\frac{10^{-6}}{10^{-4}} = 10^{-6} \div 10^{-4} = 10^{-2}$$

$$\frac{10^{-6}}{10^4} = 10^{-6} \div 10^4 = 10^{-10}$$

Also

$$\frac{10^{-6}}{10^4} = 10^{-6} \times 10^{-4} = 10^{-10} *$$

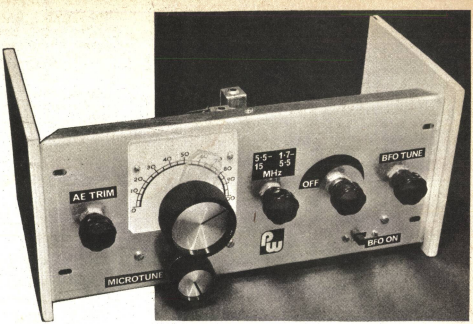
* An alternative way to deal with an index quantity that you are dividing by is to change the sign of the index and multiply, by adding the indices.

continued on page 342

GENERAL PURPOSE SW RECEIVER

Part 1

F.G.RAYER G3OGR



A frequency coverage of approximately 1·7MHz to 15MHz includes many useful bands and is obtained in this receiver by two switch-selected ranges. The tuned circuits comprise the four coils shown in **Fig. 1**, and a few points should be noted.

As an intermediate frequency of 1·6MHz is used, greater freedom from second channel interference is obtained than with a 470kHz IF. Despite this, it is not possible to avoid such interference with a single tuned circuit, especially at higher frequencies, so a matching tuned RF preselector unit is advisable and this can be added later if wished (Part 2). With the RF preselector connected the RF stage drain is supplied via R1, to make use of the primaries of the coils L1 and L2. **C1 is external to the receiver.** If it is not intended to add the RF unit, C2 and R1 can be omitted, and pins 9 of L1 and L2 connected to chassis.

Circuit Description

The 4-pole switch S1a-d selects the appropriate pair of coils. These are tuned by the ganged capacitor VC1/2. Instead of having four pre-set trimmers, TC1 is provided across VC2, and VC3 is a panel control. This provides much more latitude in alignment. VC4 is the oscillator bandspread or fine tuning capacitor, which is useful for precise tuning or listening over a narrow band.

Data for the coils used specify a 960pF padder CP1 for L3, and 340pF padder CP2 for L4 using a 2 x 315pF gang. However, 1000pF and 330pF will be suitable and are more easily obtainable. The larger capacity gang is also a standard item and simply increases coverage slightly.

In **Fig. 2**, Tr1 is the mixer with L1/L2 switched to gate 1 and the oscillator coupled to gate 2 via C6. Tr2 is the oscillator with C7 going to L3/L4 and drain feedback via S1c. As Tr1 is a protected gate device no particular care is needed beyond that generally taken to avoid overheating while soldering.

IFT1 couples the mixer output to the first IF amplifier Tr3, which also receives AGC base bias through R8 and R10, from D1. Tr4 is the second IF stage. D1 provides AGC and the audio signal developed across the volume control VR1. When S5 is closed, the BFO oscillator Tr5 is on and it is coupled to D1 by C15. This allows reception of CW (Morse) and SSB (single sideband) signals. The panel control VC5 is for adjusting the BFO frequency. Should the receiver be required for ordinary SW broadcast reception only, then S5, R14, R15, C14, C15, C16 and Tr5 and the associated circuitry may be omitted as this stage is not used for AM reception, but this is not recommended.

This circuit is assembled on a single board, with the exception of controls VR1 and VC5.

The audio amplifier consists of a TBA800 IC, **Fig. 3**, and provides useful gain and output without too much

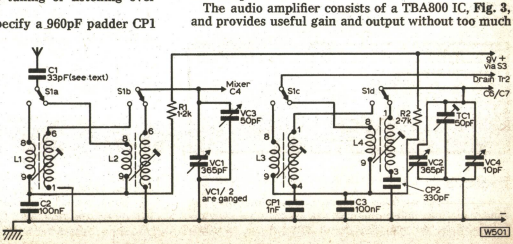
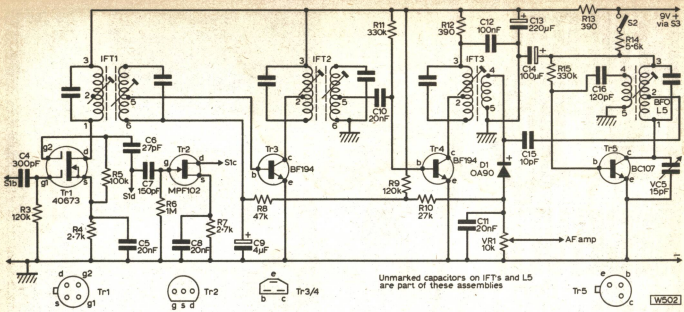


Fig. 1: The circuit diagram is shown in three parts. This circuit is of the four-coil switched aerial and mixer input section. Two bands, 1·7 to 5·5 and 5·5 to 15MHz are provided.



drain on the battery. It is intended for use with a 16Ω speaker but may be used with phones for individual listening.

The audio amplifier is wired on its own board which fits under the chassis. R19 can be two 2·2Ω resistors in parallel if any difficulty arises in obtaining 1Ω.

Metalwork

Flanged "universal chassis" members from Home Radio allow an inexpensive case to be made easily. The panel used is 9 x 4in and the chassis 8 x 4in so that it may fit inside. It is secured 1in up, with three bolts. If panel and chassis members are the same length, two corners of the chassis part must be cut away so that it will fit inside the flanges on the panel.

A clearance hole is required for the ganged capacitor which has an integral ball drive. The BFO switch S2 occupies a slot, which can be made by drilling a few small holes and filing. The mixer-IF board has four fixing bolts, and the AF board two bolts. To assure an easy fit, boards and chassis can be drilled together before mounting any components.

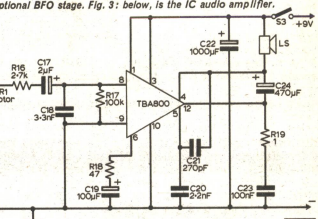
Construction

Two 4BA bolts secure the ganged capacitor. Solder a lead to the central frame tag of this before fixing it in place. It is necessary to use washers or other spacers between it and the chassis, and to watch that the bolts do not project very far inside the front of the capacitor. VR1 and other controls can then be fixed to the panel. When placing the coils on the chassis, tighten their fixing nuts **with the fingers only.** Most of the wiring in Fig. 1 can then be finished, keeping leads reasonably short and direct. If the coil pins are dull clean them before soldering. It is necessary to avoid lengthy heating of the pins and to see that they are not displaced.

Fig. 4 will assist in wiring. One tag of S6 is used as a point for R1, R2, S2 and R13 positive connections. The AF amplifier positive circuit is made at S2, under the chassis. VC4 is directly under the ganged capacitor, so a lead passes down through a hole to it from VC2. **Fig. 5** will allow the switch wiring to be checked.

Fig. 6 shows both sides of the mixer-IF board. It should first be drilled for the IFTs, including the

Fig. 2: above, shows the mixer stage Tr1 and oscillator Tr2. Tr3 and 4 are the IF amplifier stages feeding the diode detector D1.Tr5 is the optional BFO stage. Fig. 3: below, is the IC audio amplifier.



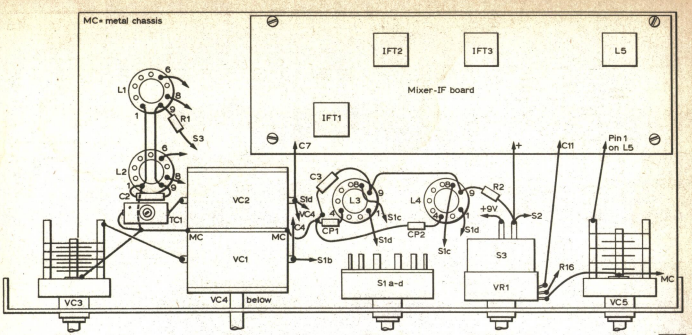
centre holes so that the lower cores can be reached. Each of the points MC is a tag secured with a $\frac{1}{2}$in 6BA bolt. Later, extra nuts allow the board to be mounted by these bolts, with clearance for wiring. Sleeving should be put on the positive circuit wiring to pins 3 of the IFTs, but is not needed elsewhere.

Provide coloured insulated leads for all external connections. These can be yellow for VC1 (S1b), black for VC2 (S1d), brown for S1c, red for positive, pink for S2, and yellow-green for VR1. When the board is fixed with lock nuts, cut these leads as required and solder them to the capacitor and other components.

The audio board is wired as in **Fig. 7**, and is mounted in the same manner as described for the other board. Connect R16 to VR1 wiper and positive to the positive line at S2. The board is placed under the chassis, at the right. It is important to note that both sides of the speaker circuit are insulated from the metal and negative line.

IF Alignment

As the IFTs are pre-tuned by the manufacturer they should not be adjusted until reasonable reception is being obtained. They can then be set for maximum volume, by rotating the cores with a proper trimming tool. Choose a weak, steady signal for this



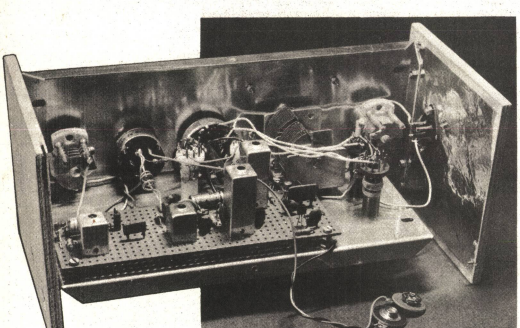
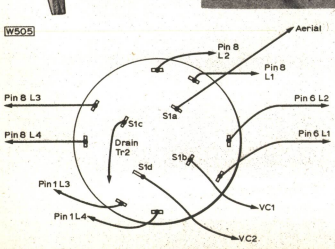


Fig. 4: above, shows the layout of the panel-mounted controls and the position of the mixer-IF board on the chassis. The photograph of the back of the receiver complements Fig. 4 and also shows the piece of aluminium foil stuck to the inside of the case to shield the coils when the pre-selector is used with the receiver. Fig. 5: below left, is the wiring between the band switch and the four coils.

W505



operation. It is a good idea to place the audio board so that the lower cores of IFT1 and IFT2 can be reached through holes in the chassis, or to raise the IF board sufficiently to reach these cores. If the latter method is used, provide a return lead from the negative line to chassis. When the five cores have been peaked up for best results, they need no further adjustment. Alternatively, a signal generator, set to 1·6MHz, may be used for precise alignment after the set is working.

BFO Adjustment

Initially tune in a steady AM signal precisely and set VC5 half closed, then switch on the BFO with S2. Set the core in L5 so that a strong audio heterodyne is heard and rises in pitch when VC5 is turned either way from the central, zero beat position. This oscillator is never in use for AM reception, only for CW

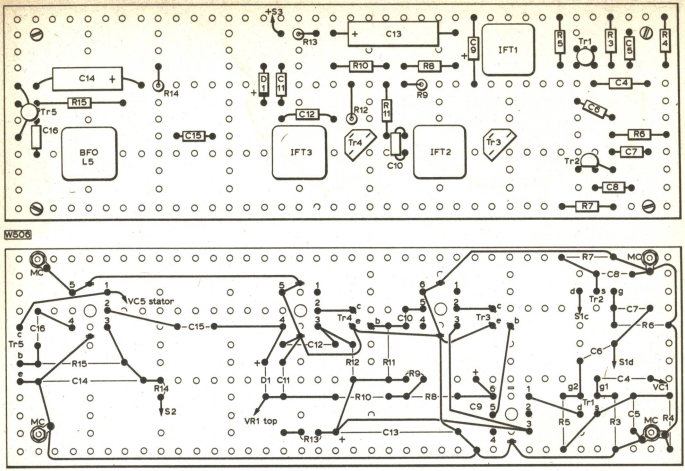


Fig. 6: Wiring and component location on the mixer-IF board is given here, from above and below. The drawings are not to scale.

★ components

Resistors

R1 1·2kΩ	R8 47kΩ	R15 330kΩ	
R2 2·7kΩ	R9 120kΩ	R16 2·7kΩ	
R3 120kΩ	R10 27kΩ	R17 100kΩ	
R4 2·7kΩ	R11 330kΩ	R18 47Ω	
R5 100kΩ	R12 390Ω	R19 1Ω	
R6 1MΩ	R13 390Ω	VR1 10kΩ log pot	
R7 2·7kΩ	R14 5·6kΩ	with switch S3	

All ¼ or ⅓W 5%

Capacitors

C1 33pF see text	C13 220μF 10V		
C2 100nF	C14 100μF 10V		
C3 100nF	C15 10pF silver mica		
C4 300pF silver mica	C16 120pF ,, ,,		
C5 20nF	C17 2μF 10V		
C6 27pF silver mica	C18 3·3nF		
C7 150pF ,, ,,	C19 100μF 10V		
C8 20nF	C20 2·2nF		
C9 4μF 4V	C21 270pF silver mica		
C10 20nF	C22 1000μF 10V		
C11 20nF	C23 100nF		
C12 100nF	C24 470μF 10V		
CP1 1nF silver mica	CP2 330pF silver mica		
VC1/2 2 x 365pF with slow motion (Jackson type O2)			
VC3 50pF variable (Jackson type 804)			
VC4 10pF ,, ,,			
VC5 15pF ,, ,,			
TC1 50pF compression trimmer			

Note:—1 nanofarad (1nF) = 1000pF

Semiconductors

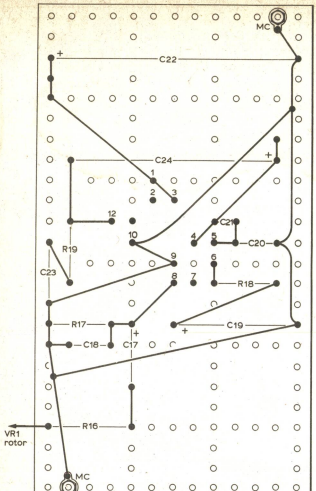
Tr1 40673	Tr5 BC107		
Tr2 MPF102	D1 OA90		
Tr3 BF194	IC1 TBA800		
Tr4 BF194			

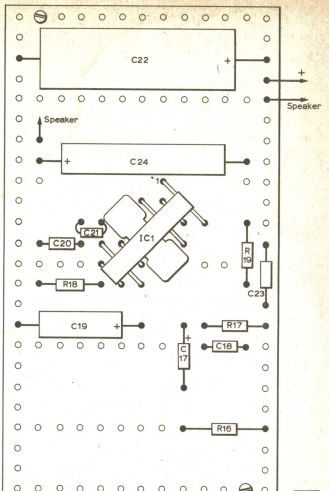
Inductors

IFT1 Denco type IFT18/1·6
IFT2 Denco type IFT18/1·6
IFT3 Denco type IFT17
L5 Denco type IFT17
L1 Denco range 4, blue, valve type
L2 Denco range 3, blue, valve type
L3 Denco range 4, white, valve type
L4 Denco range 3, white, valve type

Miscellaneous

S1, 4-pole 2-way rotary switch. S2, on-off slide switch. S3, on-off switch, part of VR1. Perforated board 0·15in. matrix 5½ x 1⅛ and 3½ x 2in. Knobs. Flanged members for panel and chassis (Home Radio). Battery PP6 9V with terminal connectors. Material for cabinet.





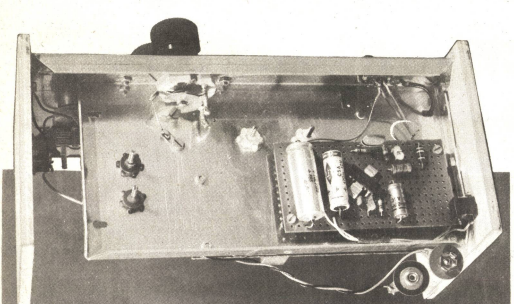


Fig. 7: above, is the piece of Veroboard, 0·15in. matrix, carrying the IC audio amplifier stage. Again, this is not to scale. This board is mounted underneath the chassis as can be seen in the photograph, left. The variable capacitor, top left, is the Microtune or bandspread tuning control, VC4.

or SSB. For CW, set VC5 to produce the wanted audio pitch. With SSB, more critical adjustment of VC5 is necessary, to obtain the best resolution of speech. Remember that lower sideband is used below 10MHz and upper sideband above.

Due to the way in which D1 operates, satisfactory resolution on SSB makes it necessary that the signal at the diode should not be too strong. When the RF stage is built, a control on this allows gain to be reduced. However, when the receiver is operated without this stage other means of reducing the input from strong SSB signals will have to be employed. Trouble from excessively strong signals at D1 will be unlikely with weak stations and a short aerial, but

will certainly occur with a better aerial, and with strong transmissions. A 50pF or similar variable capacitor in the aerial lead will then be worth while, or a small fixed capacitor as in Fig. 1.

Aerial/Oscillator Tuning

Trimmer TC1 is screwed down about half way so that when the coil cores are adjusted, signals peak up with VC3 about one-third to two-thirds closed. Band coverage is adjustable between quite wide limits and depends largely on the positions of the cores. For approximately 1·7MHz to 15MHz, set them so that about $\frac{1}{2}$in of the 6BA screwed rod projects. Subsequently, adjust the aerial coil cores, one for each band, so that VC3 allows peaking up of signals throughout each range.

Should alignment here be somewhat in error, it will be necessary to re-adjust VC3 for best reception when tuning. This will not cause any lack of efficiency, provided VC3 is neither fully open nor fully closed. Adjust the aerial coil cores near the low frequency end of the bands to minimise this. The bands covered are approximately 1·7 to 5·5MHz and 5·5 to 15MHz.

Operating Notes

Space is left inside the receiver for a PP6 9V battery. Any wire aerial, including an indoor wire, may be used. Long wire aerials should be coupled with a trimmer or other capacitor, as described, to help reduce the second channel interference which will otherwise arise. (This is greatly reduced by the RF preselector mentioned.) An earth connection will sometimes increase the volume of weak signals, especially at the lower frequencies. It is possible to arrange the coverage to tune to 1·5MHz if required, but whistles must be expected around 1·6MHz (the receiver IF).

A fairly large speaker in a suitable cabinet is best. High resistance or high impedance headsets can be used, provided a resistor is connected across them, about 16Ω. The combination is much less sensitive than when using 16Ω phones, but this is not too important because of the high audio output available.

Note that C1 cannot be left in circuit when using the preselector.

Tuning dial

The main tuning dial cursor is made from a small piece of thin clear plastic sheet. A hairline is scribed length-wise on the back. A hole is drilled to take a $\frac{1}{4}$in. internal diameter grommet which is pushed on to the spindle of the tuning capacitor before the knob is fitted. The tuning scale is also clear plastic sheet, backed with white card.

Cabinet

The cabinet can be made from universal chassis members, or some parts may be of wood. Using 6mm ply, the sides should be $4\frac{1}{2}$ x $4\frac{1}{2}$in each, and the top and back each 9 x 4in. The side near L1/L2 is lined with an aluminium plate or kitchen foil 4 x 4in to avoid coupling with the preselector coils when this unit is adjacent to the receiver.

Part 2 next month will give full details of the RF preselector for use with this receiver.

R.A.E.—*continued from page 336*

Squares and square roots

If you wish to square an index quantity it is necessary to double the index figure. For example:

10^3 squared $= 10^6$ and 10^{-6} squared $= 10^{-12}$

If you wish to find the square root of an index quantity it is necessary to half the index figure. For example:

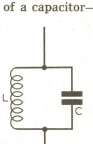
$\sqrt{10^6} = 10^3$ and $\sqrt{10^{-6}} = 10^{-3}$

If the index quantity contains a number, for example:

$\sqrt{81 \times 10^8}$ this may be represented by $\sqrt{A \times B}$. First, square root part A, second, halve the index figure of B, thus: $\sqrt{81 \times 10^8} = 9 \times \sqrt{10^8} = 9 \times 10^3 = 9{,}000$.

Indices in calculations

Let's look at a typical problem that might arise in the examination, such as finding the resonant frequency of a capacitor—inductor combination,



L = 1 microhenry (1μH)
C = 1 microfarad (1μF)

$$f = \frac{1}{2\pi\sqrt{LC}}$$

If this equation is written out in figures, it is rather large and cumbersome, as shown below:

$$f = \frac{1}{2 \times 3 \cdot 142 \times \sqrt{0 \cdot 000{,}001 \times 0 \cdot 000{,}001}}$$

By using indices it is possible to make the whole calculation much simpler. So now re-write in index form:

$$f = \frac{1}{6 \cdot 284 \times \sqrt{1 \times 10^{-6} \times 1 \times 10^{-6}}}$$

add the indices:

$$f = \frac{1}{6 \cdot 284 \times \sqrt{1 \times 10^{-12}}}$$

square root by halving the indices:

$$f = \frac{1}{6 \cdot 284 \times 10^{-6}}$$

rearrange:

$$f = \frac{1 \times 10^6}{6 \cdot 284} = \frac{1}{6 \cdot 284} \times 10^6$$

$$f = 0 \cdot 16 \times 10^6 \text{ Hertz}$$

$$f = 160 \times 10^3 \text{ Hertz}$$

$$f = 160 \text{ kilohertz (kHz)}$$

The values of L and C used in this example are not typical for this frequency but were chosen to demonstrate the use of indices in calculations.

Next month a start is made on Electricity and Magnetism, reviewing the characteristics of common components such as resistors, capacitors, transformers and magnets.

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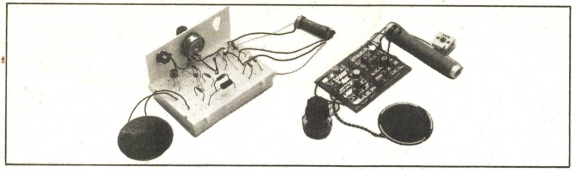

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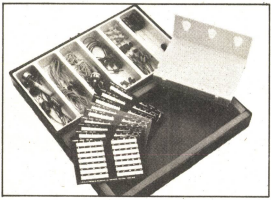

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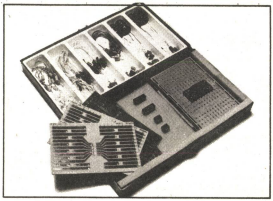

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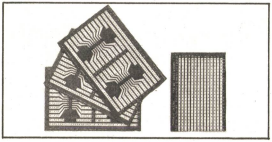

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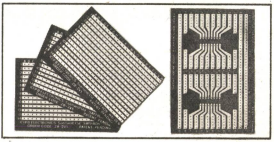

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102	10	5	7-67	1-14
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66	250	0-115-200-220-240	7-75	1-14
160	350	0-115-200-220-240	10-99	1-14
161	500	0-115-200-220-240	14-49	1-32
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330, 330	0-9, 0-9	1-99	0-38
500, 500	0-9-0-, 0-9-0	2-59	0-71
1A, 1A	0-8-9, 0-8-9	3-53	0-78
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2N2221	25p	2N3705	15p	BC212L	15p
2N2222	25p	2N3706	15p	BC213	15p
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2N2905	28p	2N3715	75p	BC251	25p
2N2906	28p	2N3716	75p	BC252	25p
2N2907	28p	2N3771	75p	BC253	25p
2N3053	28p	2N3772	75p	BC307	15p
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2N3702	15p	2N3903	28p	BC338	15p
2N3704	15p	2N3904	28p	BC347	15p
2N3705	15p	2N3905	28p	BC348	15p
2N3706	15p	2N3906	28p	BC349	15p
2N3707	15p	2N4058	28p	BC461	75p
2N3708	15p	2N4059	28p	BC477	75p
2N3709	15p	2N4060	28p	BC478	75p
2N3710	15p	2N4061	28p	BC547	15p
2N3711	15p	2N4062	28p	BC548	15p
2N3713	75p	2N4302	75p	BC549	15p
2N3715	75p	2N4303	75p	BC550	15p
2N3716	75p	2N4304	75p	BC556	15p
2N3771	75p	2N4871	75p	BC557	15p
2N3772	75p	2N4872	75p	BC558	15p
2N3773	75p	2N5172	28p	BC559	15p
2N3819	75p	2N5245	75p	BC560	15p
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2N4059	28p	2N5462	75p	BD133	89p
2N4060	28p	2N5463	75p	BD135	39p
2N4061	28p	2N5464	75p	BD136	39p
2N4062	28p	2N5465	75p	BD137	39p
2N4302	75p	2N5466	75p	BD138	39p
2N4303	75p	2N5467	75p	BD139	39p
2N4304	75p	2N5484	75p	BD140	39p
2N4871	75p	2N5485	75p	BD237	39p
2N4872	75p	2N5486	75p	BD238	39p
2N5172	28p	2N5550	75p	BD239	39p
2N5245	75p	2N5551	75p	BD240	39p
2N5246	75p	2N5589	1·70	MJE340	59p
2N5247	75p	2N5590	1·70	MJE370	59p
2N5248	75p	2N5591	1·70	MJE371	59p
2N5457	75p	2N5592	1·70	MJE520	39p
2N5458	75p	2N5769	3·95	MJE521	39p
2N5459	75p			MJE520	65p
2N5460	75p			MJE521	65p
2N5461	75p			MPF102	39p
2N5462	75p			MPF105	39p
2N5463	75p			MPS706	28p
2N5464	75p			MPSA06	25p
2N5465	75p			MPSA13	39p
2N5466	75p			MPSA56	25p
2N5467	75p			TIP29A	65p
2N5484	75p			TIP29C	60p
2N5485	75p			TIP30A	75p
2N5486	75p			TIP30C	65p
2N5550	75p			TIP31A	65p
2N5551	75p			TIP31C	60p
2N5589	1·70			TIP32A	75p
2N5590	1·70			TIP32C	70p
2N5591	1·70			TIP33A	1·50
2N5592	1·70			TIP33C	1·40
2N5769	3·95			TIP34A	1·50
				TIP34C	1·40
				TIP35A	3·95
				TIP35B	3·95
				TIP35C	3·95
				TIP36A	3·95
				TIP36B	3·95
				TIP36C	3·95
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				TIS91	75p
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				TIS98A	75p
				TIS99	75p
				TIS92	33p
				TIS93	33p
				TIP29A	65p
				TIP29B	60p
				TIP29C	55p
				TIP30A	75p
				TIP30B	70p
				TIP30C	65p
				TIP31A	65p
				TIP31B	60p
				TIP31C	55p
				TIP32A	75p
				TIP32B	70p
				TIP32C	65p
				TIP33A	1·50
				TIP33B	1·45
				TIP33C	1·40
				TIP34A	1·50
				TIP34B	1·45
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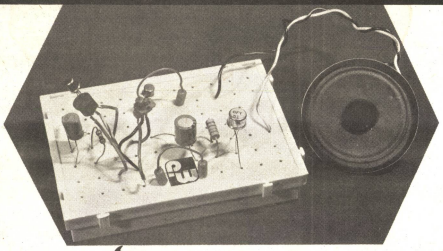


DAVID GIBSON

10

THIS MONTH

'Record Player Amplifier'

This month's project is a simple record player amplifier which is suitable for use with a ceramic cartridge. Although the output could not be fairly described as hi-fi, it does give useful volume which is acceptable in terms of quality.

The prototype used a small 58mm diameter 80Ω loudspeaker but a larger diameter unit would undoubtedly improve the apparent volume and quality, particularly in the base notes. Any speaker with an impedance from 60Ω to 80Ω will be satisfactory.

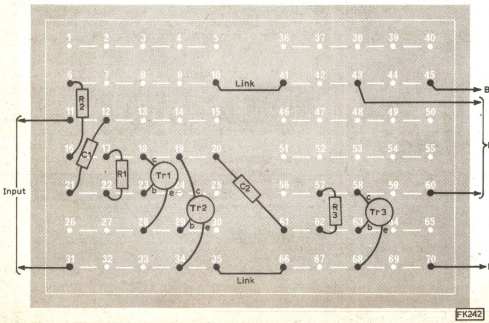
Circuit description

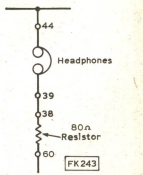
The circuit, **Fig. 1**, is basically a two-stage amplifier. Transistors Tr1 and Tr2 connected in a Darlington pair configuration form the first stage. This useful arrangement has two main advantages. The first is that a great deal of amplification is possible. The total current gain from such a circuit is found by multiplying the gain of Tr1 by that of Tr2. In practice it is difficult to calculate exactly what the gain will be because individual transistors have quite a spread in their gain characteristics.

Secondly, the Darlington stage also keeps the input currents very small indeed. In terms of power consumption the two Darlington connected transistors drew less than one fortieth of the total current of the whole amplifier.

Resistor R2 forms an audio load for the Darlington pair while base bias and DC stabilisation is provided by negative feedback resistor R1.

The first stage is capacitor coupled to the output stage, Tr3 via capacitor C2. Again, in the interests of simplicity, a lone resistor R3 provides bias and





The left-hand drawing is a full-size S-DeC layout showing component locations The smaller drawing (above) shows how a series resistor of about 80Ω must be used when operating the amplifier with low impedance headphones.

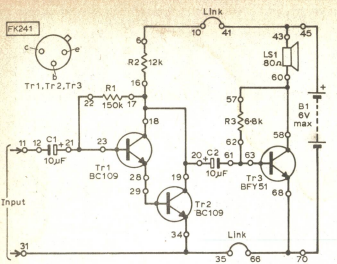


Fig. 1 : Circuit diagram of amplifier.

stabilisation. There are two important points to note. First, do not use very low impedance speakers in this circuit, i.e. 3, 4, 8 or 16Ω units. Secondly, note that both capacitors are electrolytics and must be connected with correct polarity. The positive lead of C1 must go to S-DeC hole 21 and the positive lead from C2 must be pushed into hole 20.

Remember the two shorting links which connect together holes 10/41 and holes 35/66 respectively. It is all too easy to forget these since they are not actual components.

This little amplifier works well from any voltage between 1·5V and 6V although sensitivity and output are lower at the lower voltages. At 1·5V the circuit draws approximately 6·5mA; at 3V it is 16mA, at 4·5V it is 25mA and at 6V, 34mA. With 6V applied, the current taken by Tr1 and Tr2 was found to be well under 1mA.

The lead from the record player pick-up should be of the screened variety. The centre conductor should be connected to hole 11 while the screening wire mesh goes to hole 31.

you will need . . .

R1	150kΩ	R3 6·8kΩ	Tr1 BC109
R2	12kΩ		Tr2 BC109
C1	10μF		Tr3 BFY51
C2	10μF		LS1 60 – 80Ω loudspeaker
One S-DeC			6V Battery

The amplifier provides an excellent and inexpensive general purpose unit and to this end is probably well worth transfering to a piece of Blobboard to form a permanent piece of equipment.

A crystal microphone connected to the input (holes 11 and 31) worked well; the unit would make a very useful intercom amplifier by using another, similar speaker as a microphone and connecting this to the input. The amplifier could also be used as the audio section of a radio receiver—even a crystal set—and headphones may be connected if required. Most types offered for hi-fi and record monitoring purposes are of the low impedance kind and it would be wise to insert an 80Ω resistor in series with the phones if this application is envisaged. ●

next month in Television

● ONE-CHIP TOUCH TUNING

Mechanical station selection using a combined potentiometer/switch assembly is the most common method employed in sets equipped with varicap tuners. Our constructional project next month describes an exceptionally easy method of going "all electronic", based on a Plessey touch-tuning i.c. Connection to the receiver is via the existing leads used for the mechanical selector. The unit is powered from the 33V tuning supply and uses i.e.d.s for channel indication.

● A DAY IN THE LIFE OF . . .

It's that man again. Who else but Les LJ, commenting on an average (?) day's business, faulty sets, dropped Avos, troublesome customers and all.

● IC BURST GATE GENERATOR

A precisely timed burst gate pulse is essential for correct colour reception. This can present problems for the constructor, especially if his test equipment is limited. An effective answer is the use of a simple monostable i.c. to provide the pulse.

● PYE HYBRID COLOUR SETS

The Pye 691/693/697 chassis were produced in large quantities: Andy Denham provides a run down on the stock faults.

● VCR RECEIVER CONVERSION

Older TV sets were not designed to operate with VCRs and can't usually follow the more variable line sync pulses in a VCR's signal. A complete solution is to fit a modern line oscillator i.c. designed for switching between off-air and VCR operation.

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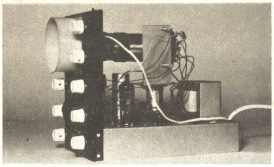

1 Build an oscilloscope.

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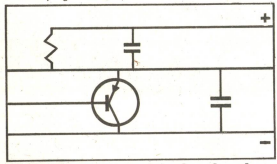

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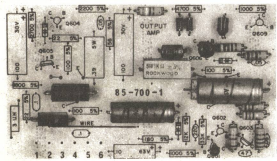

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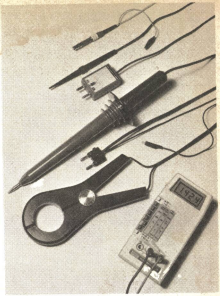
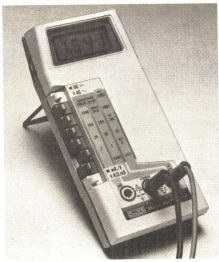


A free hand from Fluke

Possibly a little on the expensive side for a lot of our readers, but if you are in the market for a new multimeter, don't rush out and buy the first you see, think about the new Fluke model 8020A digital multimeter.

Incorporating a ½in 3½ digit LCD, the various functions and range push-button selectors are so arranged as to allow one-handed operation. The latest CMOS/LSI circuitry is used throughout, and this together with an LCD, ensures that the small 9V alkaline cell lasts for up to 200 hours.

Apart from the usual features of a multimeter such as ten voltage ranges, six resistance ranges, and current measurement up to 2A, the 8020A incorporates three diode test functions and two conductance ranges. In the case of the former of these two functions, the meter applies sufficient voltage to turn on a semiconductor junction, so that diodes and transistors can be tested for the correct forward bias voltage in situ. Individual paralleled resistors can also be checked without the need to disconnect them from the circuit.



The two conductance ranges enable measurement of resistance as high as 10,000M ohms, thus making possible the checking of HV dividers, leakage in capacitors, PCB's and cables.

Overload protection is also part of this new meter, with full protection against 300V DC continuous, or 6kV transients on any range. Priced at £99 and guaranteed for 2 years the 8020A is complete with test leads and instruction manual, although the versatility of this meter could be extended by purchasing a high voltage probe, RF probes, temperature probe and external battery eliminator.

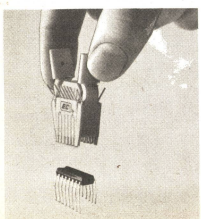
ITT Instrument Services, Edinburgh Way, Harlow, Essex. Tel: 0279 29522.

IC test clip

Walmore Electronics have introduced a unique DIP test clip which is designed to provide positive contact to eliminate the possibility of accidental disconnection from a device. Called the DIP/LOC it has contacts which provide a wiping action with the DIP leads and end-contacts hook under the DIP's end-leads in a lock-on action.

14 and 16 pin versions are available, while cable connections can be made quickly and easily with barrier strips between contacts to prevent lead shorting.

Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London.



Cassette centre

Not everyone wants a mini-recording studio in their sitting room as would appear from the complexity and price of many of the commercially available cassette decks. Plustronics, who have recently acquired the Aiko brand, are now marketing the Aiko ATP-711 stereo cassette recorder which is complete with twin speakers and microphones, and would suit the person who requires a good quality recording system, and yet is not too expensive.

Power output into the 8 ohm speakers is claimed to be 5W per channel while frequency response is 50 to 12,000Hz. Controls are of the slider type, with recording level monitored by twin VU meters. Priced at around £117 the Aiko ATP-711 can be obtained from the usual Plustronics stockists.

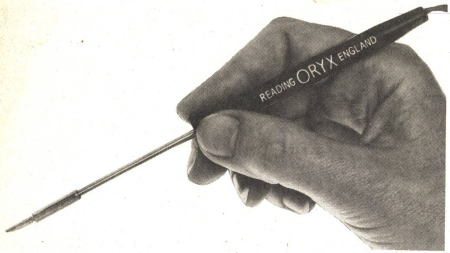
Plustronics Ltd., Hempstalls Lane, Newcastle, Staffs. Tel: 0782 615131.

Flyweight iron

Components seem to be getting smaller and smaller these days, and this coupled with the fact that many of todays IC's are extremely heat and voltage conscious makes the job of soldering a hazardous affair. Now, thought to be the smallest iron in the world, comes the Oryx model 9 low voltage iron that weighs in at only 6 grammes.

Manufactured by Greenwood Electronics, the element is claimed to give an improved and longer working life, and is available in either 6V, 12V or 24V models. The maximum tip temperature reaches 325°C while power consumption is about 8·3W. The complete iron is only 160mm long and costs £3·02 from the manufacturers or from the usual retail stockists.

Greenwood Electronics, Portmann Road, Reading, Berkshire, RG3 1NE. Tel: Reading 595844.



Tidy tubs

Take a look in one of your drawers in the kitchen, the chances are that if not all of them, at least one of them will be full to overflowing with bits and pieces, pens, pencils, clips and other things which may "come in handy" at some future date. Any attempt to tidy up results in the mess being transfered to another draw, but it's just possible that a new device produced by Platignum (the pen people) will solve this age old problem. Called Tidy-Tubs, it comprises six plastic tubs of varying dimensions joined together to form a "hold-all" for all those small bits that lie in the bottom of draws.

Tidy-Tubs come in six colours, cost £1·50 each, and should be available from all good department stores and stationers.

Multi-pin resistor

A new style of resistor recently to enter the UK market, has been launched by National Semiconductors. The resistors comprise 0·1in pitch SIP resistor networks available in 6, 8, and 10pin epoxy coated packages, with two styles being offered for each size package. In styles 605, 807 and 109, pin 1 is common to all resistors in the package, whereas in styles 603, 804 and 105 each individual resistor is brought out to a separate pin.

Line terminating resistor networks are available in 8 and 10pin styles with resistor values R1/R2 being 180/390 ohms or 220/330ohms respectively. All styles are rated at 0·125W, and have a tolerance of ±2%.

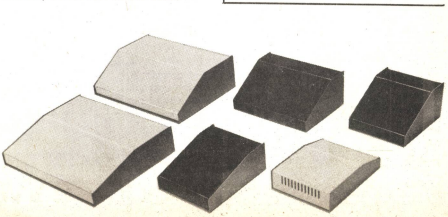
Any further information from National Semiconductors Ltd., Stamford House, Stamford New Road, Altringham, Cheshire. Tel: 061-928 3417.

A good case

Recently introduced by Boss Industrial Mouldings is a new range of aluminium containers, notated the BIM7000 range with a choice of either 15° or 30° sloping front panels. They comprise two sections each and are supplied in blue/off white, green/sand and gold/satin black colour combinations for base and sloping panels respectively.

16 sizes are available, all of which have ventilation slots in both the base and rear vertical panels.

Boss Industrial Mouldings Ltd., Higgs Industrial Estate, 2 Herne Hill Road, London, SE24. Tel: 01-737 2383.



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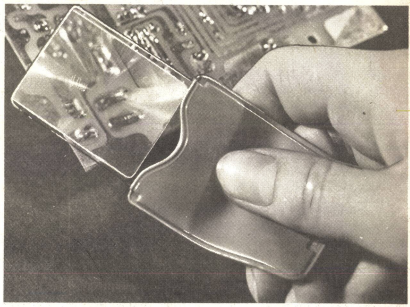


Now! You can avoid disappointing results with that new project by checking for dry joints and solder bridges on your printed circuit boards with our FREE Pocket Magnifier. Inspect your handiwork in detail. There's a dozen other uses for this handy gadget.

ALSO

SOLO SUPERMIND

Losing a few friends through boredom seems to be a hazard of some current "logical" games. October PW features SOLO SUPERMIND, which not only makes the "codemaker" redundant, but permits you to set and break your own codes. Simple circuitry, using readily available transistors disposes of the need for expensive "chips". It's effective, engaging, and cheap to build.

and:

Audio Level Indicator

Inexpensive Sine~Square Wave Generator

The Jubilee is an electronic chord organ with automatic vamping coupled to a three instrument rhythm section. It incorporates a number of features normally found only on the more expensive commercial instruments such as variable sustain length, percussion and other effects. Although automatic organs of this type have been available on the commercial market for a few years they have previously been put out of court for the home constructor because of their inherent complexity and high cost. Nevertheless we have overcome some of the problems with a novel design; simplicity of construction has been obtained by using three specially designed organ integrated circuits—developed for the professional manufacturer by General Instrument Microelectronics. These revolutionary integrated circuits are now available to the amateur.

Vamp playing

The author, like many readers, is fascinated by electronic organs and the sounds that they produce but, unfortunately, is not sufficiently dextrous to get the best out of a conventional instrument. For this reason every effort has been made to design an instrument that will produce a wide variety of sounds and which can be played by the absolute novice. In practice the melody of a tune is picked out by one finger of the right hand and a four or five note chord (Major, Minor, Major 7th or Minor 7th in any key) is selected by one or two fingers of the left hand (the latter depends on the constructional method adopted as will be seen from reading on). The left hand chords can be played in a static form or can be vamped with an alternating bass note by selecting a suitable rhythm on the tab switches.

A vast range of music is available that enables the person with no previous experience to learn to play in a few minutes. Perhaps the best examples are those written with the Lowrey and Farfissa automatic organs in mind; these scores are sometimes referred to as 'Minute Music' or 'Speed Music'. Apart from these specially written music sheets it is easy to play any music that contains guitar chord notation. The Jubilee will capture the interest of any child and, although it is no substitute for proper music lessons, it provides an incentive to learn to play a more conventional instrument in due course. For those of us with somewhat longer teeth it is a superb fun instrument providing hours of relaxation which can be appreciated by other members of the household!

Keyboards

Again, like many readers, the author dislikes messy constructional projects which involve lots of discrete point-to-point wiring. This is usually typical of organs and, apart from leaving plenty of scope for error, it turns an interesting project into a bit of a chore. For this reason we have tried to keep construction to the assembly of components on a single printed circuit board and this includes the novel keyboard arrangement suggested for the *Mark I* version. In this example we have used calculator keys instead of a normal keyboard which would need a wiring loom. Calculator keys can be used quite satisfactorily because generally speaking only one has to be depressed at a time and slick fingering is not necessary because of the built-in sustain facility.

PW presents THE 'jubil

M.J. HUGHES, MA, C.Eng.

★ specifications

Three octaves for melody line with three principal tone colours plus any combination of these.
Variable length sustain.
Variable depth Vibrato.
Percussion effect.
Repeat percussion effect (for banjo and mandolin sounds—by judicious use of length sustain can also simulate xylophone, glockenspiel etc.).
Variable repeat rate.
Two octaves of accompaniment.
Automatic chording giving all major, minor, and seventh chords.
Two principal tone colours plus their combination.
Percussion effect gives piano, guitar or banjo accompaniment.
Automatic vamping with alternating and walking bass.
Rhythm section comprising bass drum, snare drum, and cymbals.
Six selectable rhythms—synchronised with vamping accompaniment.
Rhythms may be mixed.
Variable rhythm speed.
Independent volume controls for melody, accompaniment and drums.
Internal 1W amplifier drives loudspeaker direct or phono output.
Single board construction—no wiring loom needed for keyboard.

ELECTRONIC ORGAN

Part 1

IERE

★ collated components list

Resistors

1 off 5·6Ω ¼W	34 off 10kΩ
3 off 220Ω	1 off 12kΩ
1 off 330Ω	11 off 22kΩ
1 off 470Ω	1 off 33kΩ
3 off 680Ω	1 off 68kΩ
2 off 1kΩ	10 off 100kΩ
2 off 1·2kΩ	2 off 470kΩ
1 off 2·2kΩ	3 off 1MΩ
4 off 3·3kΩ	2 off 3·3MΩ
11 off 4·7kΩ	

All 10% ¼W except where stated

Capacitors

5 off 1nF Polystyrene	1 off 1μF
3 off 33nF Polysytrene	2 off 2·2μF 15V Electrolytic
2 off 10nF	1 off 10μF 25v Electrolytic
1 off 15nF	1 off 47μF 25V Electrolytic
3 off 22nF	1 off 100μF 25V Electrolytic
1 off 33nF	1 off 1000μF 25V Electrolytic
10 off 100nF	1 off 2200μF 25V Electrolytic
5 off 220nF	2 off 4700μF 25V Electrolytic
10 off 470nF	

All polyester 10% (voltage greater than 25V) except where stated

Transistors

1 off BFY71
8 off BC148

Diodes

6 off 1N914 (or 1N4148)
1 off 3V 400mW zener
2 off DIL 1 Amp bridge type VM18 (Marshalls)

Preset potentiometers

1 off 5kΩ
3 off 10kΩ
3 off 100kΩ
5 off 500kΩ

All sub miniature horizontal

Spindle potentiometers

2 off 5Ω lin
3 off 10 kΩ log*
1 off 100 kΩ lin
1 off 1 MΩ lin

* One of these should have ganged mains switch for conventional keyboard version.

Integrated circuits

7 off 741	1 off AY-1-0212 (Top octave generator
1 off NE555	4 off AY-1-5050 (7 stage divider)
1 off 4011	3 off AY-1-1313 (Priority latches)
1 off LM380	1 off AY-5-1317A (Chord generator)
1 off 7812	1 off AY-5-1315 (Rhythm generator)
1 off LM320-12	Specify 'Pattern 004—Jubilee' for the latter

NOTE: All devices prefixed 'AY' are by General Instruments. These devices are available from Technomatic Ltd., Watford Electronics and other advertisers in the magazine.

Miscellaneous

1 off mains transformer (Double 12V 1A secondary)—Douglas type MT71-AT
*13 off single pole one way sub-min toggle switches
*1 off double pole change over sub-min toggle switch
*51 off AB Metals low profile calculator buttons (0·6" square)—available from WKF Electronics, Whitwell, Near Worksop, Notts.
1 off 1A mains fuse and panel mounting holder
*1 off mains slide switch
1 off indicator lamp and holder (optional)
1 off printed circuit board (Reader's PCB Service)
DIL sockets or Soldercons for IC mounting
Board pins (quantity depends on version being built)
Standard jack socket ¼" (for loudspeaker output)
5-pin 180° DIN socket (for phono output)

* If the conventional keyboard version is built the 14 toggle switches can be replaced by organ rocker tabs and the calculator keys by a four octave keyboard with single pole make contacts having common busbars. The mains slide switch is replaced by a ganged switch on melody volume potentiometer. Extra components required for the conventional version are:
stereo jack socket ¼" (for link to foot controlled Minor and Seventh switches)
Pair of foot operated push-to-make switches

Maplin Electronic Supplies are able to supply suitable foot switches. They also have limited stocks of 4 octave keyboards having the lowest octave in reversed colours (white accidentals). They can supply gold wire for making single pole contacts or, alternatively, low cost contact blocks can be obtained from Harmonics (Bromley) Ltd., Oakley Grange, Plaistow Road, Kirdford, Billingshurst, West Sussex. The latter require palladium busbars which Harmonics can also supply.

Some people might feel that they would prefer a conventional keyboard—certainly the sound of the instrument warrants the extra cost and trouble involved—and if so they can use the same printed circuit board with no changes except for the omission of the calculator keys. Flying leads are taken from each key position to the respective single-pole single-way contacts under each note of the keyboard.

In this part we shall describe the overall workings of the instrument and pay special attention to the large scale integrated circuits used. Constructional details will start next month and in order to allow time for ordering and delivery we are publishing a collated components list immediately. This might enable constructors to obtain components on favourable terms if they are purchased as a package deal.

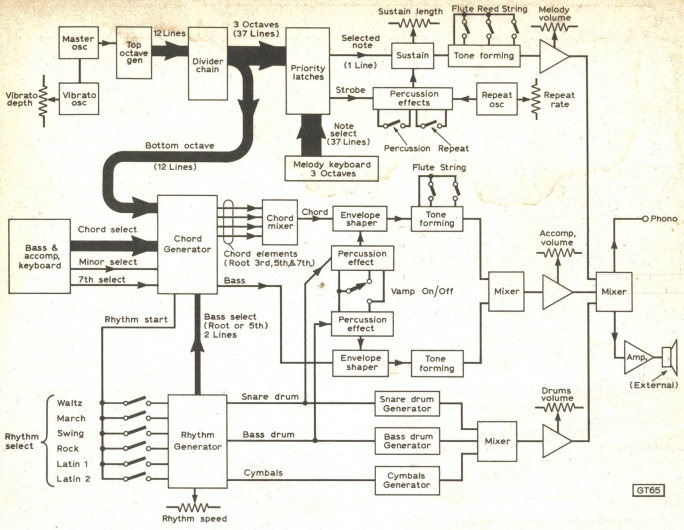


Fig. 1: Block diagram of the complete organ.

System organisation

Constructors who are more inclined to build a conventional organ, or who have already built our previously published *Easibuild Organ*, might find this single board useful in providing an additional keyboard for solo or special effects. In this application some economy can be effected because the tone generator circuitry would already exist.

A block diagram of the complete organ is shown in **Fig. 1.** A master oscillator, frequency modulated at variable depth to give vibrato, drives a conventional top octave generator. Each output of this is fed to a two stage divider except for 'C' which is followed by three stages of division to provide a total of three complete octaves plus 'Bottom C'. These notes are used to drive the priority latches for the melody keyboard and the bottom of the three octaves is fed to the chord generator.

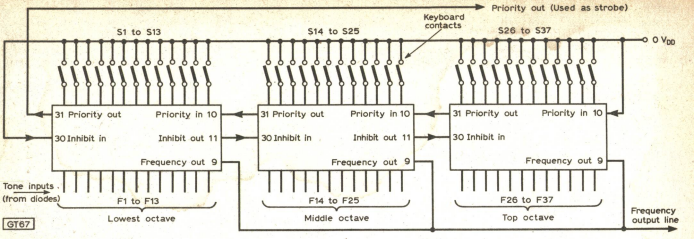
The priority latches are contained in three integrated circuits and in simple terms they are flip-flops which control a gate for each note. Each key of the melody board has its own flip flop/gate arrangement with the associated note fed from the tone generator to that gate. When the key is pressed the flip-flop opens the gate and allows the note to appear at the single line output. At the same time any other flip-flop is reset. This means that only one note at a time can be selected by the melody keyboard—it is monophonic. This, at first, sounds as though the scope of the organ is immediately limited. On the contrary. If the key just selected is released the flip-flop remains in its set state and the note remains active at the output and enables the envelope generator (built into the sustain circuitry) to hold the note over an adjustable period. This allows one note to die away slowly until a second key is pressed.

In order to synchronise the Sustain circuitry with the note selection operation we have to tell it whenever a new key has been depressed. This is easily done by making use of the internally generated 'Priority Output' signal for the priority latches. This signal in conjunction with the 'Inhibit Output' line is used within the priority latches to carry out the reset operation already referred to.

The three priority latch integrated circuits are coupled together in such a way that if two keys are pressed at the same time only the higher note will be selected. A pin connection diagram for this integrated circuit and an illustration to show how the three are coupled together in this application are shown in **Fig. 2.**

Sustain

The synchronising signal from the priority latches is called a 'Strobe'. This is fed to the percussion effects stage which changes the nature of the signal. Normally the signal is high for as long as a key is pressed—thus allowing a continuous tone through the



sustain circuit. The percussion effect, when switched in, allows only a short pulse from the strobe line and this occurs on the instant of pressing the key. The effect of this is that the note is generated for a very short period (even though the key is held pressed) and dies away according to the setting of the sustain length. Depending on the setting of the tone forming circuit the sound so produced could be like a drum stick hitting a wooden block if there is zero sustain length or like a bell being struck if there is a long sustain.

Another feature of the percussion circuit is the ability to repeat the pulse, just referred to, at an adjustable rate for as long as the key is depressed. By careful setting of the various controls one can produce sounds ranging from a xylophone to a banjo being strummed. With the repeat rate set close to the vibrato frequency very weird sounds can be produced!

Voicing

The shaped signals from the sustain stage are then fed to the tone forming circuits. We used the absolute minimum of circuitry here to keep construction simple but have managed to provide three basic tone colours. In electronic terms these are a heavily filtered square wave which gets close to sinusoidal, a straight square wave, and a spike waveform. These closely resemble the tone colours usually referred to as Flute, Reed and String respectively. The apparently small choice of tone colours is deceiving. By modifying their envelopes, they provide a wide range of sounds

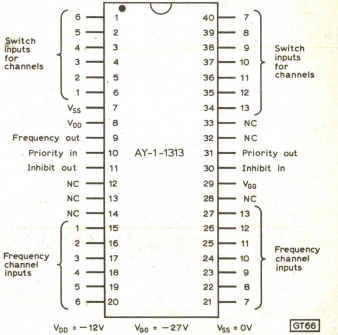
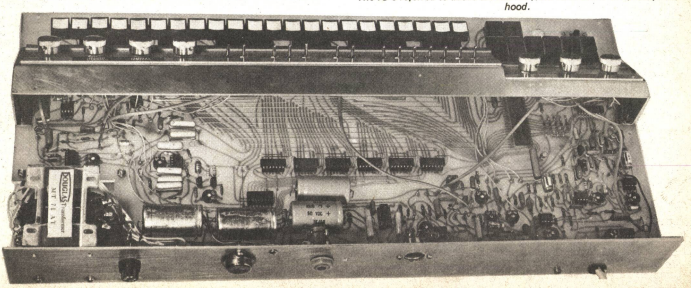


Fig. 2 (above and top) : Pinout and simplified interconnection diagram, for the three priority latch IC's AY-1-1313. Among other functions, these circuits ensure that, if two notes are pressed at the same time, only the higher one will sound.

The picture (below) shows a prototype organ and has been included solely to give readers some idea of the work entailed in construction. The IC's referred to above are hidden from view under the front panel hood.



ranging from ecclesiastical to modern plus the instrumental effects, some of which have already been mentioned. The signal is then fed to a pre-amplifier where its volume is independently controlled prior to joining with other signals at the power amplifier.

Chord and rhythm generator

The more complex part of the instrument is the accompaniment section which is built around General Instrument's chord and rhythm generator ICs.

As the chord generator concept is relatively new to the amateur it is worth spending a few paragraphs describing how this chip works. Its pinning diagram is shown in **Fig. 3.** The generator can be used in two configurations. One requires 36 separate keys to select the major minor and seventh chords for a complete octave. The alternative configuration requires 12 contacts to select one of the major chords and utilises two extra switches to convert the selected chord to minor and seventh respectively. The latter configuration is used to economise on keyboard facilities. This means that not all the input pins of the package are utilised. The schematic stage shown in **Fig. 4** might be of more help in describing how the device functions in our configuration.

The twelve notes of the bottom octave from the tone generators are connected directly to input pins 13 to 24 and a capacitor and resistor are needed to set the frequency of the internal keyboard multiplexing oscillator. If the key designated 'C' is pressed the generator switches the respective notes of the bottom octave that go to make up the chord of 'C Major' on to the chord element output lines. 'C' would appear at pin 31 being the root note, 'E' at pin 29 as the third and 'G' at pin 28 as the fifth. These three elements

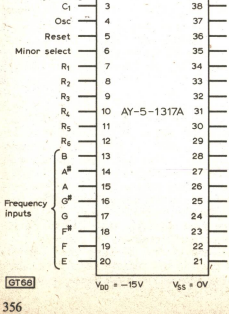
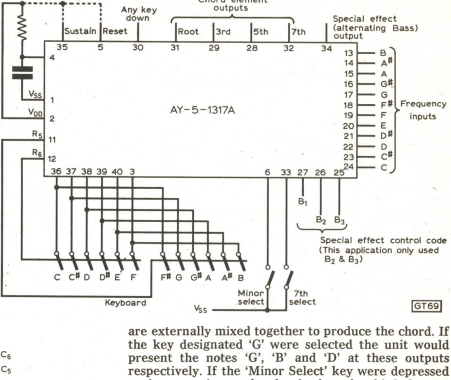


Fig. 3 (below): Pinout details of the AY-5-1317A chord generator.

Fig. 4 (right): Simplified interconnection diagram of the chord generator. This chip operates in conjunction with the AY-5-1315 rhythm generator IC to produce both chords and walking bass effects.

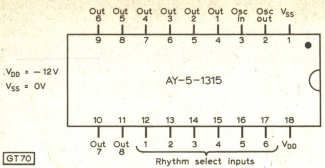


Although we intend to publish reduced scale artwork for the PCB in the next issue, full size etching artwork will be available from the editorial address at the front of the magazine, price 40p. Send a cheque/postal order for 40p together with a large (at least 13" × 11") stamped and self-addressed envelope. Ready-made boards will be available from the Readers PCB service as usual, see ad.

are externally mixed together to produce the chord. If the key designated 'G' were selected the unit would present the notes 'G', 'B' and 'D' at these outputs respectively. If the 'Minor Select' key were depressed at the same time as the chord select, the third element at pin 29 would be changed to a note a semitone lower. If '7th Select' were depressed an extra note would be presented at pin 32. This would be the note a full tone below the root of the chord in question (in both major and minor keys). When this extra note appears it is mixed with the three others producing a very pleasing chord that is frequently used in music notation.

The output designated 'Any Key' is very important. It is made active whenever a key is pressed. It is therefore used to start the rhythm generator in synchronism with a key depression. In the main block diagram this link is anotated 'Rhythm Start'.

Pin 34 is called the 'Special Effects Multiplex Output'. Its effect is not quite so difficult to understand as its name implies. For a given chord selection we can obtain either the root, third, fourth, fifth, sixth or seventh element at this output but naturally only one of these six options at a time. The option is set by the binary code being fed to the control inputs at pins 25, 26 and 27 according to Table 1. If the codes



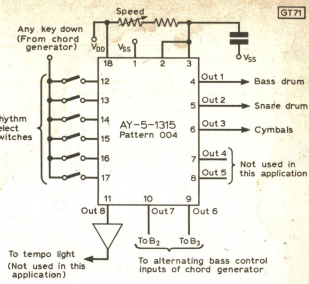


Fig. 5 (above and right) : The pinout and simplified connection diagram of the AY-5-1315 rhythm generator. Readers should specify 'pattern 004' when purchasing this IC.

were generated sequentially, it would create an output sequence of the elements comprising the chords. The chord generator chip divides these elements by 1, 2 or 4 so that they fall at least one octave lower than the chord outputs, thus producing a bass note. If the selection were sequenced while a chord was being held it would have the essentials of a walking bass.

Table 1

Pin 27 (B1)	Pin 26 (B2)	Pin 25 (B3)	Note Selected
0	0	0	No change from last note
0	0	1	Root
0	1	0	Fifth
0	1	1	Third
1	1	1	Seventh
1	1	0	Fourth
1	0	1	Sixth

In our application we do not make full use of all the special effect options—we only use two of the control inputs (pins 25 and 26). These are coupled to the rhythm generator which is pre-programmed to change the code in synchronism with the rhythm patterns. This gives an alternating bass which is sounded at the same moment as the bass drum beat.

Vamp

It should now become easier to understand the details shown in the main block diagram for the accompaniment section. If we assumes that the vamp switch is off, the percussion effect circuits can, for the moment, be ignored. When an accompaniment key is pressed the selected chord elements are presented to the mixer, pass straight through the envelope shaper and on to the tone forming circuits producing two voices 'Flute' and 'String' (Sine and spike respectively). With none of the rhythm select switches closed and the rhythm generator chip outputting the correct code on the bass select lines, there will be a continuous note on the bass output line. This will be the root note of the chord in question.

The bass line from the chord generator is fed to its own envelope shaper and thence to a single tone colour filter. This provides a filtered square wave which sounds reasonably mellow and full. Both the chord and the bass line are mixed before being fed to a volume control and pre-amplifier.

When the Vamp switch is on, the bass note and chord are produced in exactly the same way but do not get through their respective envelope shapers until these receive trigger pulses from the snare drum and bass drum outputs of the rhythm generator. These pulses are short and give a fast attack to the accompaniment which is followed by a decay set by the sustain circuit within the envelope shapers.

Component values are pre-determined to make the bass note sound like the string of a bass guitar being plucked. Depending on whether flute, string or both are selected, the chords will sound as if played on a piano, banjo or guitar. The bass guitar sounds on the bass drum beat while the chord is struck in synchronism with the snare drum.

When switched to Vamp mode, the accompaniment signals will only appear at the output if the rhythm generator is running; ie if one of the rhythm select switches is on.

Rhythm

The GI rhythm generator used in this project **(Fig 5)** is mask programmable so that manufacturers can design their own rhythm patterns. It is not economic to do this for small quantity purchasers so we have settled on one of the standard patterns already being produced by GI. This gives a reasonable selection of six beats, as shown on the figure, but a feature of this circuit is that the rhythms can be mixed by selecting two or more at the same time. Although the chip produces five instrument outputs (plus the alternating bass control signals) we are only using those for bass drum, snare drum and cymbals. These pulses are fed to noise generator circuits which are coupled in a mixer before being fed to their own pre-amplifier. This, again, has its own volume control.

By having separate volume controls on the melody, accompaniment and drum lines the overall balance may be adjusted to individual preference. It also means that the drums can be reduced to zero level while maintaining operation of the rhythm unit which keeps the vamp going. One can operate the accompaniment and drums section in various modes depending on the set of the instrument tabs. For example one can have straight chords with a static root base note; one can have static chords with an alternating bass and drums or a complete vamp—alternating bass syncopated with the chords and drums.

Next month we shall start on constructional details and describe the various circuits as we go along.

If you take delivery of the GI Integrated Circuits before the next part do not remove them from their protective packing unless you take steps to prevent damage from static electricity!

DESIGN YOUR OWN PROJECTS

No.1 LIGHT TRIGGER

TOBY BAILEY & BOB WHITAKER

This series describes how to design experimental projects for yourself. Each month we hope to set ourselves a reasonably simple problem, produce a set of specifications to which we want our circuit to conform, and design an appropriate circuit. We will give an account of the possibilities we explored and the thought processes we used to arrive at the final circuit, together with details of how we calculated (or guessed!) component values and why we chose particular component types. Last, but not least, we will provide an honest report of what happened when we built our circuit.

One point requires particular emphasis. These are meant to be one-off projects and the methods used to design the circuits will, in some cases, be more casual in approach than they might be if the circuit were, for instance, being designed for mass-production or in the form of a kit or completed unit. This is not because we want to be condescending or that we think that you might need protecting from some of the complexities. It is simply because this is the method of design used by almost all amateurs of some experience when they are experimenting.

Problem

For the first circuit we decided to tackle the well-worn problem of producing a device which will turn on a light when the evening becomes dark enough. This old favourite often appears under names such as "electronic candle" or "automatic nightlight" or some similar title. With a bit of luck we will try to show that designing one of these devices for your own specific requirements is not as daunting a task as it might appear at first. Of course designing your own circuit from scratch is not as easy as ferreting out a published design in the back issue of a magazine, but that is not the point.

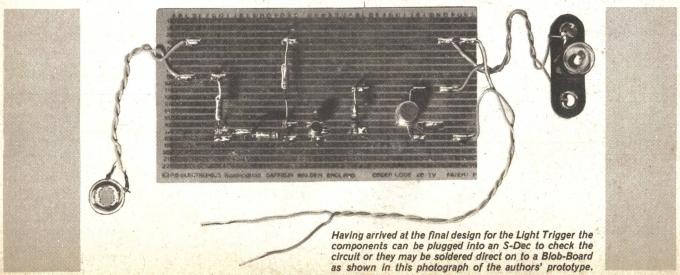
Specification

So, what exactly are we trying to do? Let's not be overly ambitious, and stick to driving an ordinary torch bulb. The first one we unearthed from the bottom of a drawer has the markings "6V-60mA" still barely decipherable on the side. This seems a pretty reasonable one to use as it doesn't require a terribly unusual power supply anyway. We also need something to sense the light intensity so a light-dependent resistor (LDR) should be just the job. Bob happened to have one of dubious origin attached to a piece of equipment of even more dubious function, from which it was duly severed.

It seemed that the most sensible way of finding out the charactertistics of this LDR was to measure its resistance with a meter. A couple of minutes later we possessed the facts that when it was so dark that we could hardly read the meter the resistance was at least 100kΩ and with rather dingy lighting the value decreased to about 10kΩ. We decided fairly arbitrarily that the circuit should switch somewhere between these points and that we didn't particularly mind where.

Design

It would seem pretty perverse to use anything but 6V for the power supply and, short of using a relay which would be absurdly expensive for our modest



Having arrived at the final design for the Light Trigger the components can be plugged into an S-Dec to check the circuit or they may be soldered direct on to a Blob-Board as shown in this photograph of the authors' prototype.

★ components

R1	2·2kΩ	¼ or ½W 5%
R2	2·2kΩ	
R3	220Ω	
R_F	100kΩ	
LDR	ORP12	Bulb 6V 60mA and holder
Tr1	BC109	Blobboard ZB-1V
Tr2	BFY51	(PB Electronics Ltd.)

requirements, we are going to end up by driving the bulb directly from a transistor. So, let's start from that end and see how we get on. The next question that needs to be answered is "does the bulb go in the emitter or the collector?" If we put it in the emitter circuit we shall have to drive the base between about 0·5V and 6V to turn the transistor off and on, whereas if the bulb is in the collector circuit then a much smaller voltage swing is required to get the same effect. As the textbooks more formally put it: "Emitter-follower and common-emitter amplifiers have about the same current gain but the latter has a much higher voltage gain than the former."

So let us accept the extra voltage gain as a bonus, it's free and there does not appear to be any obvious disadvantages associated with our choice of the common-emitter circuit. We now have a circuit like that of **Fig.1.**

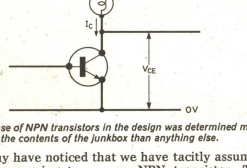


Fig. 1 : The use of NPN transistors in the design was determined more by the contents of the junkbox than anything else.

You may have noticed that we have tacitly assumed that we are going to use an NPN transistor. The reasons for this are by no means deep and not entirely unconnected. Firstly, we both have rather more of the NPN type than PNP and, secondly, they tend to be marginally cheaper. Now we need to decide which particular transistor to use, especially since a collector current of 60mA is not small enough to ensure that any transistor we try won't blow up. The highest power dissipation in the transistor is when the collector is at half the supply voltage, i.e. V_{CE} = 3V. This enables us to calculate the dissipation, given by V_{CE} x Ic, and we get P = 3 x 60 = 180mW. Now the allowable dissipation for most common small transistors (e.g. BC109, 2N3704 etc.) is around 300mW so we seem to be fairly safe here.

But wait a minute! When a light bulb is just turned on the resistance of the filament is much lower than it is after the filament has had a chance to heat up. This means that the current and hence the dissipation will be rather larger at turn-on. We measured the cold resistance and found that this meant that the peak collector current would be about 150mA, giving a dissipation of 450mW for a short time. To be on the safe side let us use a BFY51 which can take up to 800mW. Our catalogue tells us that the minimum gain is 40 but neglects to specify the current to which this figure refers. Oh! well, let's say 30 then. This means that we need 2mA at the base of our BFY51 to turn on the light. The stage we have now reached is summarized in **Fig.2.**

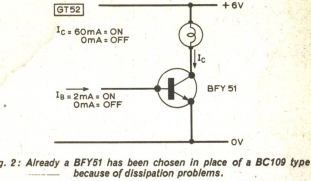


Fig. 2: Already a BFY51 has been chosen in place of a BC109 type because of dissipation problems.

At this point it now becomes abundantly clear that we are going to need another transistor. Since the minimum resistance of the LDR at which the bulb must be turned on is 10kΩ we would need 20V to pass 2mA through the LDR. So how do we connect the second transistor? It can be either NPN or PNP and can be driven from either the emitter or the collector, giving the four possible circuits shown in **Fig.3.**

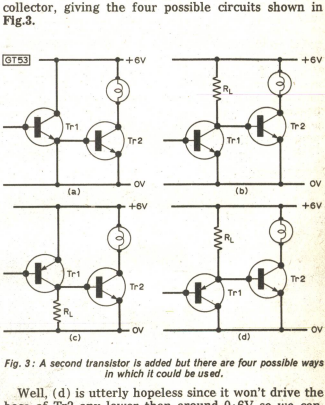


Fig. 3 : A second transistor is added but there are four possible ways in which it could be used.

Well, (d) is utterly hopeless since it won't drive the base of Tr2 any lower than around 0·6V so we cannot even guarantee to turn it off. In (c) Tr2 is not going to last very long if Tr1 turns on heavily since Tr1 will then supply a large base current to Tr2. We now have to choose between (a) and (b) both of which use a NPN Tr1. (a) suffers a similar defect to (c) in that we are going to have to be very careful that we do not supply too much base current to Tr1 in order to protect Tr2. Also it is conceivable that when Tr1 is turned off the leakage current might be high enough to upset Tr2, especially if the latter has rather more gain than our conservative estimate.

Circuit (b) seems to be best and we shall now proceed, using this one.

Practical Values

The next thing to work out is the value of RL. When Tr1 is turned off there will be about 5·5V across RL which then has to supply 2mA to the base of Tr2 (we are ignoring the leakage of Tr1 which should be negligible). For this condition we get $R_L = \frac{5 \cdot 5}{2} = 2 \cdot 75k\Omega$ so let's use a 2·2kΩ resistor to be on the safe side. Having fixed this value we can now work out that Tr1 will have to sink a current of $\frac{6}{2 \cdot 2} = 2 \cdot 7mA$ in order to turn off Tr2. So we want a nice little low power high gain device for Tr1, something like the ubiquitous BC109 should be sufficient, **Fig.4.**

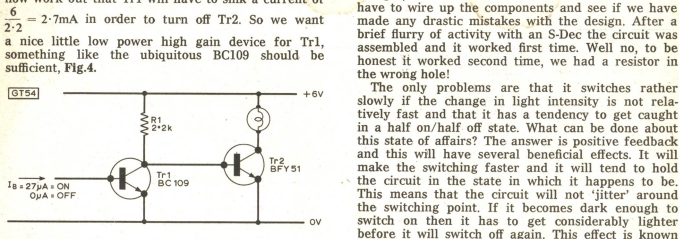


Fig. 4: The value of the load resistor for the BC109 has been decided upon.

The gain of a BC109 is stated as lying in the range 200 to 800. If we assume a value of 100 at worst we're going to need a base current of up to 27μA to turn on Tr1. Well, we want the BC109 to turn on when the resistance of the LDR drops to a low enough value so we are going to have to connect the LDR from the base up to the positive power supply line as shown in **Fig.5.**

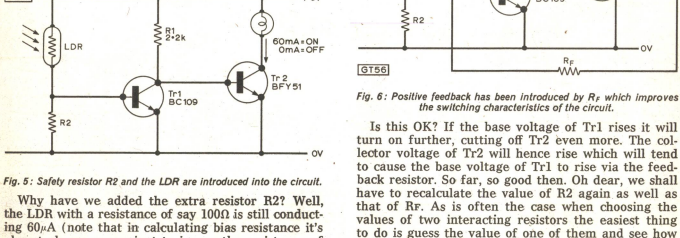


Fig. 5: Safety resistor R2 and the LDR are introduced into the circuit.

Why have we added the extra resistor R2? Well, the LDR with a resistance of say 100Ω is still conducting 60μA (note that in calculating bias resistance it's almost always convenient to ignore the resistance of the base-emitter junction: more correctly the input resistance). Let's assume that if the LDR is at 100kΩ then we want to pull the base of Tr1 down to a 3V to leave a good safety margin. For this condition R2 has to have a value of at most $\frac{0 \cdot 3}{5 \cdot 7} \times 100 = 5 \cdot 3\Omega$ so 4·7kΩ seems safe enough. Now if the value of the LDR drops to 10kΩ the base voltage will rise to $\frac{4 \cdot 7}{4 \cdot 7 + 10} \times 6 =$ 1·9V. We had better just check that the 27μA base current now being drawn by Tr1 does not effect this too drastically. Well, the current being drawn by the bias network of the LDR and R2 is over 400μA so the 27μA not required by the base is going to make hardly any difference and we have a good margin of error with a base voltage of 1·9V.

Moment of truth

Right, now comes the moment of truth when we have to wire up the components and see if we have made any drastic mistakes with the design. After a brief flurry of activity with an S-Dec the circuit was assembled and it worked first time. Well no, to be honest it worked second time, we had a resistor in the wrong hole!

The only problems are that it switches rather slowly if the change in light intensity is not relatively fast and that it has a tendency to get caught in a half on/half off state. What can be done about this state of affairs? The answer is positive feedback and this will have several beneficial effects. It will make the switching faster and it will tend to hold the circuit in the state in which it happens to be. This means that the circuit will not 'jitter' around the switching point. If it becomes dark enough to switch on then it has to get considerably lighter before it will switch off again. This effect is known as 'hysteresis'. How can we achieve this desirable characteristic? Well, the only convenient place from which to take the feedback seems to be at the collector of Tr2, as shown in **Fig.6.**

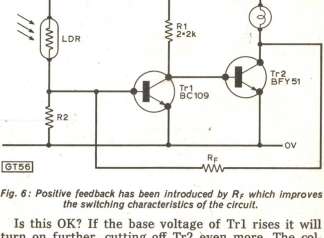


Fig. 6: Positive feedback has been introduced by RF which improves the switching characteristics of the circuit.

Is this OK? If the base voltage of Tr1 rises it will turn on further, cutting off Tr2 even more. The collector voltage of Tr2 will hence rise which will tend to cause the base voltage of Tr1 to rise via the feedback resistor. So far, so good then. Oh dear, we shall have to recalculate the value of R2 again as well as that of RF. As is often the case when choosing the values of two interacting resistors the easiest thing to do is guess the value of one of them and see how it goes. How can we go about guessing a reasonable value for RF then? Looking at the circuit it is apparent that if RF has a much lower value than that of the LDR then the LDR will never be able to change the state of the circuit. If RF is too large its effects will be reduced and we won't get enough hysteresis. Hence we shall choose a value of RF comparable with that of the LDR, say 100kΩ.

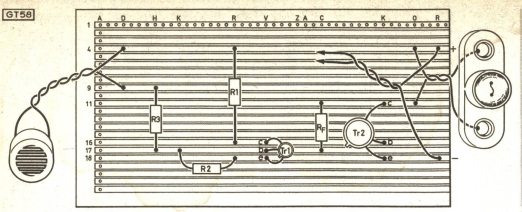


Fig. 8: Layout of components on a Blob-Board, if this method of construction is adopted. A photograph of this board appears on the first page of this article.

Now when the collector of Tr2 is at 6V RF must not be able to turn on Tr1 without the aid of the LDR. Let us aim to try and get the base voltage down to 0·3V, at least. With an LDR resistence of 100kΩ we have an effective resistance between the base and the 6V line of 50kΩ (100kΩ+100kΩ in parallel) so we can calculate R2 to be $\frac{0{\cdot}3}{6{\cdot}0 - 0{\cdot}3} \times 50 = 2{\cdot}63\text{k}\Omega$, so let's say 2·2kΩ. We have now got to check that

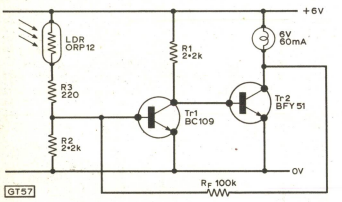


Fig. 7: Final circuit with values of all the components.

when the LDR has a value of 10kΩ the circuit has turned off. If Tr2 is on then RF will effectively be in parallel with R2 and hence the former may be ignored as its resistance is fifty times higher. So, ignoring the base current again, we find that the base voltage of Tr1 is $\frac{2{\cdot}2}{10 + 2{\cdot}2} \times 6 = 1\text{V}$ so this is plenty to turn on Tr1. We can now draw the final circuit as in **Fig.7.**

You will see that a 200Ω resistor has been added in series with the LDR. The truth of the matter is that neither of us noticed until we constructed this stage that there is the possibility that if the LDR resistance drops down to the 100Ω region (in very bright light) then we would have about 6mA of base current in Tr1. Whilst little harm is likely to come to our BC109 because of this it seems wasteful and the series resistor will protect Tr1 if one of us manages to short out the LDR in an aberrant moment.

The circuit now switches cleanly and quickly regardless of the slowness of change of the light intensity and it is impossible to get the output into an intermediate state.

If you wish, you can build the circuit on a PB Electronic's 'blob board' such as the ZB1V as shown in **Fig.8** and the photograph.

Postscript

Well, we have finished now. You may wonder why at each stage we took fairly pessimistic values for the gain of our transistors and chose our resistor values so as to give something in hand over the value we actually calculated. The idea is that all this gives us sufficient in reserve to deal with all the little things we did not consider such as running the transsiistors at voltages and currents different from those at which the gain is specified, resistor tolerances or variation of battery voltage.

We hope that it is going to be one of the main messages of this series. For experimental projects you can ignore all these minor effects providing that you design sensibly with "power in reserve"!

Next month's contribution will describe the design procedure for the circuit of a power supply intended to operate a cassette recorder in a car.

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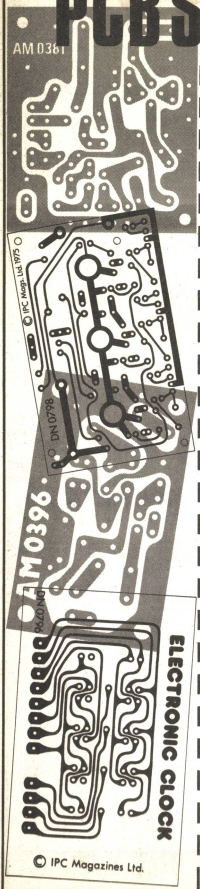

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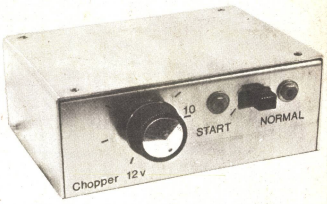
electronic CAR VOLTAGE REGULATOR

C.GRAYSON B.Sc

In this age of sophisticated electronics in the car the traditional method of regulating the supply voltage by a pair of vibrating contacts with all the associated pitting, arcing and electrical noise, is, to put it mildly, outmoded. Therefore, this simple but reliable electronic regulator was designed.

The 'chopper' was originally designed to be a regulator for motorcycles but it can be calibrated for any DC field and armature, dynamo generating system. A CMOS integrated circuit was chosen for the heart of the circuit because of its high immunity to electrical noise, of which there is a great deal in car systems, and its ability to operate at a variety of supply voltages, of which there is precious little on a motorcycle.



The one control on the Regulator adjusts the voltage while the slide switch enables the system to be started up if the car battery is flat.

IC Details

Some readers may be unfamiliar with the integrated circuit used in this project. It is the RCA CD4007A described as a 'dual complementary pair plus inverter' and its internal configuration is shown in **Fig. 1.** Basically the device consists of three CMOS inverters in various stages of dismemberment. Consider the inverter comprising p1 and n1. These are, respectively, a 'p' channel and an 'n' channel enhancement mode MOSFET. These may be considered as a resistive bar of 'p' or 'n' type silicon overlayed with an insulated metal electrode. The potential on the electrode (gate), controls the number of holes or electrons allowed to pass along the bar from source to drain. Thus, each MOSFET is basically a voltage controlled resistor with an R_{ds} on of about 500Ω and an R_{ds} off of greater than ten thousand megohms! Now if pins 13 and 8 are connected together on the CD4007A and a positive voltage is applied to pin 6 then the 'n' channel MOSFET is in the ON state and the 'p' channel is OFF. Thus, the output at pins 13 and 8 is the inverse of the input. In the 'chopper' two inverters are formed with the inputs at pins 6 and 10. The third 'p' channel device is not used but the 'n' channel is used in isolation as a voltage controlled resistor.

The Circuit

Now we can consider the circuit **Fig. 2,** of the 'chopper' in greater detail. Transistor Tr1, diodes D1 and D2, and resistors R1 and R2 form a constant current source of about 8mA which feeds D7 and C1 to give a regulated voltage of about 4V, which is fed to the supply pins of the IC. In the final analysis, this is the reference voltage for the whole system as the voltage-resistance characteristic of the feedback MOSFET is not absolute but relative to the substrate potentials.

The heart of the circuit is a CMOS oscillator with the halves of its cycle separately set in duration. The basic CHOS oscillator is shown in **Fig 3.** If, say, the output of N2 is high then C_{te} becomes charged positive, consequently the input to N2 is high and its output is low, thus C_{te} is discharged to ground through R_{te}. When the voltage on the input of N1 passes through its transfer point, the output goes high and

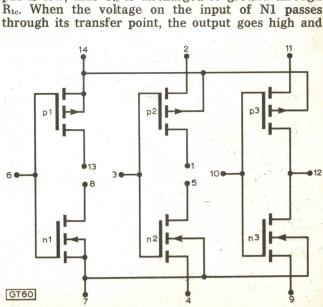


Fig. 1 : Basic circuit of the CD4007 IC used in this project as a 'chopper'.

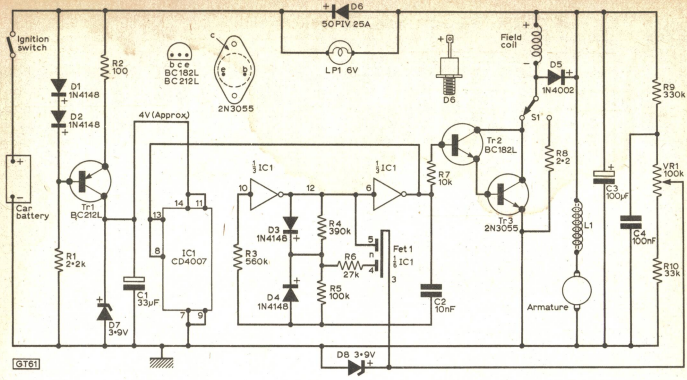


Fig. 2: The complete circuit of the Regulator. It is essential that the transistor Tr3 and Diode D6 are insulated from the metal case with the proper insulating kit or washers.

as a result the output of N2 goes low charging C_{tc}. Now R_{tc} provides a charging path for C_{tc} until the transfer point is again passed and the cycle repeats. For an ideal transfer point of 50% of the supply rails the time period of each half of the cycle is about $0{\cdot}7R_{tc}C_{tc}$ but this rises to around $1{\cdot}1R_{tc}C_{tc}$ when R_x is included to limit the current through the input protection diodes of N1 and to make the frequency of the oscillator relatively free from supply voltage variations.

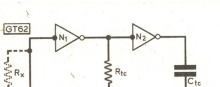


Fig. 3: Basic circuit of the CMOS oscillator, the operation of which is described in the text.

In the voltage regulator the oscillator is used to chop the supply to the field coil of the dynamo. Obviously, the longer the current is allowed to flow in the field coil via Darlington pair Tr2, Tr3, then the higher will be the armature voltage. Accordingly, the OFF period is set at 1·25ms by C2 charging through R5 when the output of N1 is high and the ON period is variable from 350μs to 5ms depending on the combination of R4, R6 and the D_{ss} of FET1.

The action of the circuit is as follows; when the machine is started up there is no voltage fed back by potential dividing chain R9, R10 and VR1. Hence, the R_{ss} of the FET is almost infinite and the field coil is energised with a 4:1 mark-space ON waveform and the armature voltage rises to feed the vehicle battery, light, etc through power diode D6 (which is necessary to prevent current feeding back from the battery into the armature winding). A proportion of this voltage is fed back to the gate of the 'n' channel FET to lower the total resistance presented to C_{tc} as an ON time discharge path. Thus, the field coil is excited for a lower proportion of the time and the voltage tends to fall. The converse is true, and a state of equilibrium is reached and the voltage is stabilised irrespective of engine speed or load. If VR1 is set to tap off less voltage then the regulated voltage at the anode of the power diode will rise to maintain the equilibrium thereby giving a wide range of control. The inductance of the field and armature coils combine to integrate the pulsed drive waveform to give a smooth output voltage.

★ components

Resistors

R1	2·2kΩ	R5	100kΩ	R9	330kΩ
R2	100Ω	R6	27kΩ	R10	33kΩ
R3	560kΩ	R7	10kΩ	VR1	100kΩ linear pot
R4	390kΩ	R8	2·2Ω 5W		

All resistors ¼W 5% except R8

Capacitors

C1	33µF 16V electrolytic	C3	100µF 25V electrolytic
C2	10nF paper foil	C4	100nF disc ceramic

Semiconductors

Tr1	BC212L	Tr3	2N3055
Tr2	BC182L	IC1	CD4007A
D1/4	1N4148	D6	50V PIV 25A
D5	1N4002	D7/8	Zener 3·9V (BZY88C3V9)

Miscellaneous

Insulating kit for 2N3055. Insulating washers for D6. Aluminium case approx 100 × 70 × 40mm or larger. S1, slide switch DPDT (connect contacts in parallel). LP1, lamp 6V 40mA. L1, 50 turns 26SWG insulated copper wire on 10mm dia. ferrite rod. PCB from PW Readers PCB Service.

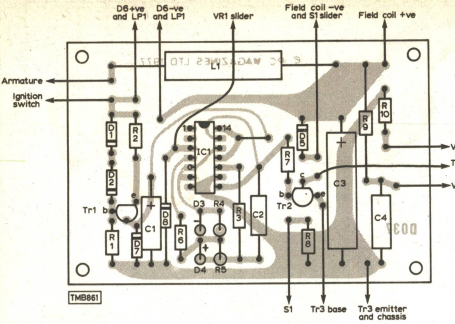


Fig. 5: The components mounted on the PCB are fitted as shown here. Check the lengths of the leads required for fitting the unit to a particular vehicle before soldering them to the board.

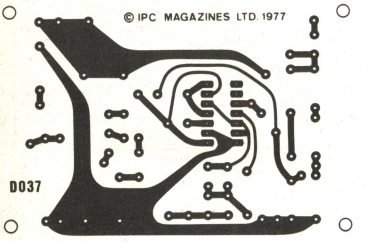


Fig. 4: Foil pattern of the printed circuit board, shown here actual size.

Anyone who has looked at the output of a car dynamo armature will attest to the apparent lunacy of connecting a delicate CMOS input directly to it. The 'chopper', however, incorporates a second order L-C low-pass filter comprising L1, C3 followed by a first order R-C low pass with R9, C4 to eliminate the hash from the output. Further protection is afforded by D8 which prevents any voltage greater than 4V appearing at the input which would forward bias the internal protection diodes and damage the integrated circuit. Finally, D5 protects the driving transistors from induced high reverse voltages. LP1 is the dashboard discharge lamp which glows when there is a reverse voltage across D6, and S1, R8 provides the facility to start the system up if the battery becomes very flat or disconnected.

Construction

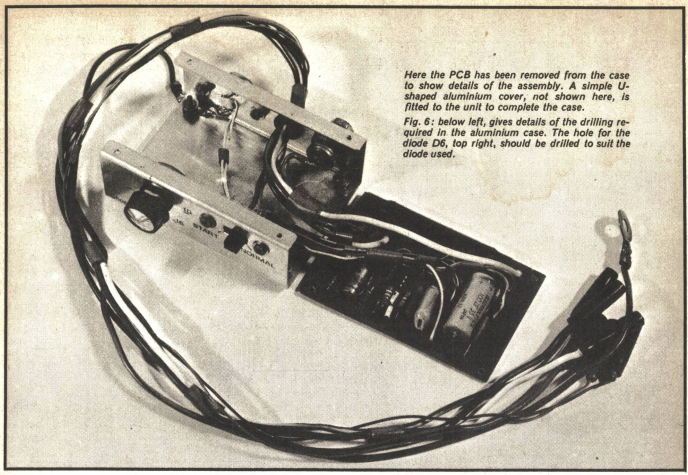
Good solid construction is of the greatest importance where the circuit is to be exposed to the hot, dirty and vibrating environment of the road. Assembly is greatly eased by the use of the PCB shown in **Fig. 4.** Coil L1 is formed by winding about 50 turns of 26 SWG insulated wire on a 70mm length of 10mm diameter ferrite rod. The whole assembly may be conveniently secured to the board with epoxy resin. After L1, mount the passive components followed by the semiconductors and finally the integrated circuit. Care should, of course, be taken in handling CMOS. The supply pins should be soldered first with a well-earthed iron followed by the remaining pins. Component layout is shown in **Fig. 5.**

The board is mounted in a standard 100x70x40mm aluminium box. Tr3 and D6 are mounted on the rear face as shown in **Fig. 6.** S1 and VR1 are similarly mounted on the front face. As the power transistor operates in the switched mode very little power is dissipated and the aluminium serves more as a convenient mounting than a heatsink. The collector of the transistor is electrically isolated from the earthed chassis by a mica washer and bushes. The power diode is similarly mounted through a 10mm hole, again, under all but the most exceptional of circumstances, no heatsink is required. Wiring is quite straightforward but care should be taken to use heavy gauge copper wire in the high current section of the circuit.

Setting Up

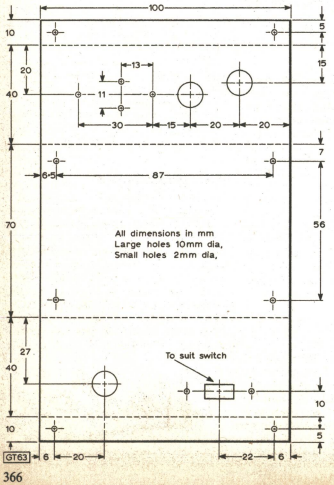
The usual configuration in the electromechanical regulator situation is for one end of the field coil and one brush of the armature to be connected to the chassis while the other ends (usually marked F and D) go off to the regulator where they are joined by a resistor of some 3 to 4Ω. Now the earthy end of the field coil must be disconnected and wired into the circuit with the other two terminals as shown in **Fig. 2.** A little trial and error may be necessary with the values of R9, R10 and VR1 to give the correct range of adjustment and voltage.

As the characteristics of dynamos and CMOS devices vary so much a greater degree of control may be required. To achieve this the value of **R4** may be increased to 1MΩ while R6 is decreased to 10kΩ to give a 10:1 variation in mark-space. With



Here the PCB has been removed from the case to show details of the assembly. A simple U-shaped aluminium cover, not shown here, is fitted to the unit to complete the case.

Fig. 6: below left, gives details of the drilling required in the aluminium case. The hole for the diode D6, top right, should be drilled to suit the diode used.



the values as shown the range of adjustment is from 10V to 16V on a Lucas type C40-1 generator. For a 6V system reducing R9 to 100kΩ and R10 to 10kΩ should prove to be about right.

When adjustments are complete the unit should be securely bolted to some convenient earthed part of the chassis with the leads to the dynamo, ignition switch and charging lamp taken out through a hole in the rear of the case and terminated in standard bullet connectors.

Positive Earth

Finally, it might be added that a positive earth version of the 'chopper' is quite possible and would merely involve reversing all polarised components except D3 and D4, together with transposing Tr1 and Tr2. A 2N2955 or similar pnp power transistor must be substituted for Tr3 and finally the track to the negative supply pin of the integrated circuit must be broken and the supply voltages transposed.

Now, the voltage feedback to the FET acts on the R_{ds} in the opposite sense, but the pnp transistors require the complementary logic level to turn them ON. Thus the two phase inversions cancel themselves out and the PCB layout given can still be used. However, with the advent of more electronics in the car many readers will probably wish to do as the author did and take the opportunity of fitting the 'chopper' to convert a positive earth system to the more convenient negative earth. This consists of removing both field and armature coils from the chassis and reconnecting both in the opposite sense, not forgetting to reverse the connections to the vehicle battery and any other polarity sensitive items already fitted. ●

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS
In general, the author does not have any more information on products than appears in the article.

Measured charge

One or two items currently launched on the electronics market tend to remind us of the advances made in the field. Solid state relays, for example, have edged their way up the power-handling capability curve with almost monotonous regularity. I see that one of the very latest to appear (the GB15000 type) can handle a continuous current of 40A with a peak voltage rating of 600V.

Another item is a capacitance meter. Not much bigger than a small hand-held calculator it has a universal socket arrangement for the input(s), a push-to-read button, and a liquid crystal readout. To measure the value of your capacitor, you just poke its leads into the appropriate socket holes and press the button. The unit will give capacitance values from 0·1pF right up to 0·2 Farads. The meter is auto-ranging in that a LED illuminates to show that the reading is in pF, nF, µF or mF.

Viva la weed

It used to be said that the Chinese were "damned clever", but the French seem to be making a bid for this title: would you believe an electronic greenhouse?

Heart of this system is a thing called Firmin which is contained in an area less than 5 × 5 × 8in. Firmin carefully measures things like the soil conditions, the ambient light level, evaporation rates etc. It also computes just how thirsty each plant is and then supplies it with just the right amount of water. The system operates from solar cells as a power source.

Firmin has a calculator and a memory plus a section associated with a motor which controls a valve regulating the water flow. It is continually monitoring and comparing the plants' requirements with the environment so it's quite a precise system. It must be nice for the computer in Firmin to receive an order from hollyhock number five, "A large water—and leave the bottle!"

Open sesame!

Popular electronics construction journals have often published details of ultrasonic control systems. Those interested in this area will be pleased to hear that a German semiconductor manufacturer is to launch a set of three ICs which will allow hobbyists to make an infra red control system; useful for things like opening and closing garage doors, TV control, light dimmers etc.

The system employs pulse-code modulation and is initiated by simple push buttons. Up to 60 (sixty) command signals are possible from a hand-held, battery-operated transmitter. The receiver can be built into a space about 3 × 3 × 1in.

High hopes are held for the infra red system since it has certain advantages over its ultrasonic brother. For example, in the application of opening and closing garage doors the ultrasonic system could not work efficiently from a hand held device inside the car because the "sound" waves would not penetrate the car body etc. The infra red waves, however, can pass through glass and the IR system could be simply pointed through the cars' front windscreen.

Please note: these ICs are not available as yet.

Powerful FET

The arguments regarding semiconductor devices and valves at UHF still rages, with the semiconductor people edging a little closer each year. A new device just launched is a FET which can generate 1W at 8GHz with a 9·2dB gain. Impressive though this might be for a gallium-arsenide FET, it does have rather a long way to go to compete with the VTS-5753A1. This is a travelling wave tube which has a power gain of 47dB and a peak output at 3·3GHz of 120kW. I have to smile at the valve manufacturer who said of the semiconductor manufacturers of devices at these frequencies, "Ah yes, they make Watt-nots".

Get it taped

Video cassette recorders for the home haven't really taken off as yet in the UK, probably on account of the cost. But I am pleased to learn of sensible co-operation between two European manufacturers. Although individually developed, a close consultation between them during development has resulted in two systems that are compatible. Both will now record over two hours of colour TV programmes without a cassette change. In real terms this long recording time means that an entire football match could be recorded (or even a full length feature film) all on one cassette.

A useful (?) feature on one system is a highly accurate digital clock which allows its owner to select the turn-on and turn-off times of the equipment up to four days ahead of the time that recording is required.

Interesting to note that one manufacturer claims some 90,000 video recorders are in use in West Germany, and over 250,000 in the US.

Interested?

Good news for computer enthusiasts—cheaper items are on the way. One of the newer systems costs only $495 in the US and consists of a 73-key keyboard, 9in CRT, an 8-bit microprocessor, and 4,096 bits of random access memory which operates with Basic programme language. A built-in cassette player allows easy entry of recorded programmes.

Anyone interested in this area of electronics should drop a line to Mike Reeve. He is the secretary of the Amateur Computer Club and you can reach him at 6 Limes Avenue, North Finchley, London N12 8QN. Letters should be written in Basic English!

The write beam

Print-out devices are commonly offered on the electronics market, but one just mentioned in Japan seems to be something else. It uses a laser beam to do the "writing" on a photo-sensitive drum. The letters/characters are made up to a resolution of ten "dots" per millimetre. Printout is at six lines/inch but the twist in the tail is that this printer will printout 10,000 lines every minute! Perhaps it might be called "Print Sprint"?

Ginsberg

AMATEUR BANDS

by Eric Dowdeswell G4AR

The Torbay ARS let their hair down at their AGM with no less than eleven complaints on the current operation of the RSGB. Most are long-standing, such as too-technical articles in Radcom and nothing for the newcomer to amateur radio, late and varied posting of Radcom resulting in some readers not being able to take advantage of the 'For Sale' columns. The alleged delay on book orders etc. surprises me in view of the success of the new computer system. However the 1977 President's Committee may come up with some answers in due course, although I doubt it, as the reasons for the complaints are too deep-seated to admit of a simple solution. But one of TARS complaints, that the Society's AGM is always held in London instead of being allowed to 'go on tour', should not be difficult to solve!

First item this month must concern **Barry Harper** of Wednesbury, West Midlands, who was playing around with an old radiogram when he picked up a distress message from an Italian ship in trouble off Rome. Barry alerted his local police who contacted the coastguard authorities who passed a message to Rome. Their coastguards did in fact then locate the fishing vessel in distress. Barry's local press gave him a write-up but, not unusually, got most of the facts wrong! Apparently, Barry is going to rebuild the radiogram and adapt it for SW transmission! And study for a licence to broadcast! Actually, Barry has a No. 19 set that he has been playing with, mostly on 80m, but he's not too happy with the results on SSB.

Brian Harrison in Ore, Hastings continues to find plenty of daytime activity on 10m including KV4 and 8P6, while 20m turned up an HH which is not all that common on any band. In Dringhouses, York, **John Hague** continues to swot up the code so let's hope we shall be getting some interesting CW logs from you soon, John. Scottish reader **John Overton** BRS36909 of Glasgow has been lucky enough to enlist the help of two local amateurs GM4CNF and GM4EAW and now sports a BC348 receiver in place of his old CR100. John plans to sit the RAE in December and has not forgotten to keep up with the code. Talking of the code, I hope that the Morse Tutor in the August issue of PW proves of interest, especially in the clubs, where it would make an interesting project. This month sees the start of a series for those interested in studying for the RAE, which, I hope, includes most of the readers of this column!

John Reynolds, Bridgend, still plays around with his TRF in lieu of anything better. Being still at school limits the cash available. Well, John, be patient, stick to the 'A' level studies which are, by far, the most important item at the moment and perhaps everything will come right 'ere long.

Changes at the West of Scotland ARS where **Tom Wylie** GM4FDM is now the Hon. Sec. Write to him at 38 Rosedale Avenue, Paisley, if you'd like details of their summer programme. Another reminder of the North West Amateur Radio Convention to be held on 17 and 18 September and organised by the University of Lancaster ARS. Contact P. L. Jones c/o Dept of Physics, Univ. of Lancaster, Bailrigg, Lancaster for details.

Peter Page of Epping, Essex is yet another who has returned to the bands after a long break. He has an Eddystone 840 which still worked when the cobwebs were removed! A dipole for 20m suffices for the moment but plans are afoot to improve this situation. **John McFadden** keeps going in Belfast finding plenty of South Americans on 15m in the evenings. John mentioned W7ALD/MM. I normally refrain from commenting on these maritime mobile calls since by the time it appears in print the ship is thousands of miles away somewhere else or in dock and the operator paid off!

Once a reader of this column gets his/her own licence I don't normally expect to hear from him/her again! Quite understandable, of course, since the first flush of enthusiasm lasts quite a while and every spare moment is spent on the air, not writing letters but QSL's! So it was good to have a note from **Jeremy Hinton** who now signs G4EZE (was A8962 and G8LIZ) from Newcastle in Staffs. He used the GE special prefix during the Jubilee celebrations and generated a pile-up of Europeans, just for a change. Nice for the G's to get in the act at last! Jeremy uses an FT200 transceiver into a W3DZZ multi-band trap dipole. He's getting the knack of working the DX but sometimes feels he'd like a kW and a multi-element beam! Then where would the fun be, OM?? It would all be too easy, like working through repeaters!

Another pair of fellows enjoying the DX by sharing a KW201 receiver between them are **Paul Pasquet** A9105 and **Iain Christie** A9201, near Farnham, Surrey. They have another set, built by G4DPP, kept for the BC bands. Back on the amateur bands, they have amassed 160 countries so far this year. Another event on which a reminder would not be out of place

is the RTTY lecture and demonstration by G3MFJ and G3WWF on 16 August by the Wakefield and District Radio Society at Holmfield House. Ring Bob Firth G3WWF on Leeds 825519 for details.

Alan Doherty reports from Portrush, N. Ireland, that he had little response from his appeal for readers in his area to contact him with a view to forming a club. His success with stations in the Pacific has been mostly over the long path in the mornings. He reports poor returns from QSLs sent out but that is not an unusual situation. Personally speaking, I think the average listener to the amateur bands is wasting his time getting QSLs, not to mention the expense. Much better to spend the time studying for the RAE and then to get QSLs that represent much more of an achievement, a two-way QSO!

The Midland ARS is mourning the loss of Bob Palmer G5PP a past President and long established member of the club, giving lectures and organising constructional projects for other members. He was a great contest man and frequently combined holidays with a DX-pedition. This, of course, meant a great interest in mobile rallies which often meant a lot of hard work for him. After his retirement he was able to spend even more time on his hobby. I remember working him myself on many occasions in CW contests and so I know that the Midland ARS has lost a fine operator.

Good news from **Paul Barker** in Sunderland who says that he is intending to sit the RAE in December next. He is one of many studying at home so I sincerely hope that our news course on the RAE, starting in this issue, will be of some use to him. Paul, you may remember, is a very keen SSTV type and has not entirely deserted the DX bands in search of new countries to log. Just think, Paul, you will soon be able to answer back! Paul was third in his category in the 1st. Worldwide SSTV contest but still feels he did not do as well as he might have done due to QRM. Paul now has an 18AVT vertical multiband aerial which should have gone up by now.

An interesting letter arrived at the last moment from Harry Leeming G3LLL who tells me that, provided there is sufficient support, he will once again be running an RAE course, later in the year. Send your enquiries to the Principal, The College of Technology and Design, Feilden Street, Blackburn.

Late News, page 374.

Log extracts

P. Barker:— 20m AP5HQ C6ANO (Bahamas) KZ5JM TA1MB VP8SM YB6ACV **20m SSTV** DK2ZX LZ1MH OK1KO OZ3WP WA2PCY YU1CS 9G1JX

A. Doherty:— 20m JY25YJ KA6ML KP6AL KP6BD (Kingman Reef) KX6BU TU2EF VP8HZ VR1X YS1ESH 9M8HG **10m** A9XBC PY2HY ZP5SD

P. Pasquet:— 20m PJ3BW TT8SM 3D6BE 6W8LZ **15m** VP2GAH VP8PC TR8GB 9V1SW

J. Hinton:— worked 20m JY25MB KA6SS

J. McFadden:— 15m CP5AO EA8LD EP2RL HI8XBH HK1ZF KZ5KS LU5MBC PY2FMP PZ1DR VP2LL 6Y5GB

C. Page:— 20m CT3BO HR3JJR 6Y5KD

J. Overton:— 20m HC2CG HR1JAG KH6BTD KS6FL

B. Harrison:— 20m HH2MC OY5NS ZD8RR **15m** HM5HB YN7NI 6W8FZ **10m** KV4CI YV5ATX 8P6AJ

J. Hague:— 15m EP2RR JY4JW 9H4F

All reports are SSB unless indicated otherwise.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy

Broadcasts from the Near East present quite a problem to the medium waxe DXer. The time zones of this part of the world are some two to four hours ahead of GMT which means that many of the medium wave stations there have already signed off for the night by the time European QRM starts to clear at 2300. There are a few exceptions. Bagdad is a regular on 760kHz sandwiched between West Germany on 755 and Switzerland on 764 and it can be heard throughout the evening. Another is Kuwait on 1345 which lies between the BBC on 1340 and France on 1349. Others than can be located in this way are Kermanshah, Iran on 895 just below Milan on 899, Ahwaz Iran on 1390 between European channels 1385 and 1394, Sharjah in the United Arab Emirates on 1575, between East Germany on 1570 and Norway on 1578.

An alternative is to listen between 0300 and sunrise when stations can be heard signing on for the day but the best time of all for DXing the Near East is during the month of Ramadan, the ninth month in the Moslem calendar which starts this year on the 16th August. During this period broadcasting goes on for most of the night, many stations staying on the air all night and presenting the listener with the opportunity of hearing DX that otherwise would be difficult or impossible to hear. Listen for Basra on 692; Damman, Saudi Arabia on 885; Antalya, Turkey on 890; Cairo 4 on 940; Damascus 944; Izmir, Turkey on 962; Taiz, Yemen on 1000; Istanbul 1016; Teheran 1088; Radio Oman 1240; Radio Afghanistan 1280; Aleppo, Syria 1313; Kirkuk, Iraq on 1360 and Hyderabad, Pakistan on 1010kHz. Broadcasts from the North African coast should be conspicuous during the late evening. Algeria is on 529, 548, 575 and 980; Tunisia on 584, 629, 719 and 962, Libya on 674, 827, 1124 and 1250 and Morocco on 593, 611, 701, 827 and 1232. On the long waves try for Istanbul on 182, Azilal, Morocco on 209 and Tebessa, Algeria on 251kHz.

"I was wondering if there is any publication available listing the addresses of the lower powered US stations, mainly the 5kW outlets, as I have logged a few" writes **Denis Taylor** from Preston in Lancashire. No need to worry about station addresses in North America. Use the station call letters and the location as announced over the air. For example Radio WEAN Providence, Rhode Island, USA will certainly find this 5kwatter. Denis uses a Realistic DX160 and MW loop and a few of his latest loggings are La Voz de Antioquia, Colombia on 750; WEAN on 790; All India Radio, Rajkot on 1070; Radio Tiempo, Caracas in Venezuela on 1200; Radio Coro, Venezuela 1210 and WVOJ Jacksonville, Florida on 1320.

A large souvenir QSL card issued by KDKA Pittsburg (1020) mentions that their signal has been heard at some time or other in every country in the world and Denis thinks this must confirm world-wide MW reception as mentioned recently in this column. Worldwide reception depends both on the location

of the listener and on the level of local QRM. In western Europe QRM is the main problem but it is unlikely, QRM permitting, that Hawaii and parts of the Pacific will be logged in the UK in other than freak conditions, as the Great Circle path between the UK and that part of the world passes over the north magnetic pole, a region of high absorption of medium wave signals.

"Freetown on 1205kHz is quite a good signal here around 2300, and I have just sent a report to them" says **Roy Patrick** whose QTH is in Mackworth near Derby. This station is the medium wave outlet of the Sierra Leone Broadcasting Service and it goes off the air at 2335 daily with a half hour extension on Saturday. Programming is largely in English. This station does QSL and the address is simply Radio Freetown, New England, Freetown, Sierra Leone.

Roy mentions that the long wave Algerian outlet on 251kHz has been off the air for a few weeks but is now back in service and transmits the French programme of RTA. Another item from Roy concerns MEKO 2 which is now testing from a harbour in Libya, presumably with the permission of the Libyan Government. It has been heard in Derby on 773kHz with announcements in English until it goes off at 2300 (0100 local time).

A letter from **Paul Griffith**, who lives at St James', in Barbados, refers to a MW loop he is constructing. "I ran into a snag in that I am unable to locate a 500pF tuning capacitor in Barbados and have had to order one from the UK" says Paul. This problem has faced some DXers in the UK as well since 500pF variables do not seem to be in demand, other than by constructors of a medium wave loop! Twin-gang capacitors of around 300pF per section are readily available though and one solution to the problem is to use a single section of a twin-gang to tune the HF end of the band and to switch-in the second section in parallel to cover the LF end. There will be some overlap but the additional capacitance when both sections are in use and the vanes closed, will extend the range by only a few kHz, perhaps to 500kHz instead of 540kHz.

The maximum value (vanes closed) of the tuning capacitor is not at all critical. It is the minimum value (vanes open) that is important as it is this amount plus the self-capacitance of the loop and wiring that will determine the highest frequency at which the loop will resonate. For this reason it is not a good idea to use a twin-gang with the two sections in parallel to cover the whole band. If the loop cannot be tuned to a low enough frequency with the vanes closed then the total capacitance is too low and will have to be increased by switching in additional capacitance. This can either be a fixed capacitor or the second section of a twin-gang variable. There is ample scope for the experimenter who can use a twin or triple-gang capacitor from an old radio or a single gang of lower value than 500pF. One design of loop seen by the writer used a 365pF variable, a switch and a 220pF fixed capacitor to cover the band in two sections, thus getting round the difficulty some DXers experience in constructing a loop that will cover the entire range from 540kHz to 1600 kHz.

My original article, 'Medium Wave DXing', which dealt with a practical loop aerial, appeared in PW for April 1970. Back numbers are not available but Eric Dowdeswell, Asst. Editor, is arranging for reprints to be made. Send an SAE **to me** if you are interested.

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Derek Bell

It is with regret that these paragraphs that I write are the last. Over the many years, since December 1974, that I compiled the Short Wave News I have made many friends and, I trust, have helped and entertained many more. I started writing the column with the firm intention of serving all aspects of our hobby from aerials to QSL card collecting. It was never my intention to be a "Radio Times" section and I hope that the items of news and information that were put in helped to broaden my readers' horizons. Indeed it is to these very readers that I owe a debt of gratitude since, were it not for their letters, there would have been no column to write, so if anyone can employ a redundant typewriter jockey any offers will be gratefully received!

Having got that out of the way we will pass on to this month's letters and start with **Roy Patrick** from Derby who passes on the information that Radio Canada is now airing a short DX show on Sundays at 2043. Is this a sign that they are at last reinstating their formerly highly active DX section? Roy also tells me that Radio Nacional Brazilia is to cease its international service due to "technical reasons".

While on Latin Americans, **Alan Proctor** of Bristol has sent an interesting letter on the best verifiers on that continent. He nominates Radio Nacional Bogota and Radio Guaiba, and says that they replied in less than three weeks. Alan does say however that he enclosed two IRCs and, in one case, some Jubilee stamps. These seemed to attract the attention of a staff member who sent a personal reply and Alan is now a firm advocate of the personal touch.

My recent remarks concerning the oldest DXer prompted a reply from **Arthur Leir** of Belfast. While not, let me hasten to add, a candidate for that title, Arthur has been an addict since 1939 when he started with an Eddystone 504. He has QSL cards dating from pre-war which must be something to see. After a lull Arthur had the urge to re-enter the hobby and has purchased a VEP204, and asks about the various publications on the market. Well, Arthur, Short Wave Magazine is still extant but personally I would buy World Radio and TV Handbook from Argus Books, Station Road, Kings Langley, Herts.

It is one of life's ironies that DX strikes in the strangest places. **Andrew Brade**, aged 13, has an old domestic Ferguson 391T with a forty-foot long wire hung on the end. Added to this the cord drive to the dial has broken and so Andrew has to rely on verbal IDs but despite this he has two loggings that deserve a mention, Radio Grenada on 15105 at 2015 and this month's star prize for Voice of the Malayan Revolution on 15790 at 0940 and Andrew logged it for a week. It is reported in WRTVH as a 120kW from Hengyang, China, but I have never seen it reported before.

Recently this column arranged for the delivery of a number of spare speakers to a group of bedfast

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TRIACS—Plastic TO-220 Package Isolated Tab

	1A (a)	(b)	3A (a)	(b)	6A (a)	(b)	10A (a)	(b)	15A (a)	(b)
100V	0-60	0-60	0-70	0-70	0-78	0-78	0-83	0-83	1-01	1-01
200V	0-64	0-64	0-75	0-75	0-87	0-87	0-95	1-17	1-17	1-17
400V	0-77	0-78	0-80	0-83	0-97	1-01	1-13	1-19	1-70	1-74
600V	0-96	0-99	1-01	1-10	1-21	1-25	1-42	1-50	2-11	2-17

N.B.—(a) without internal diac. (b) with internal diac.

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7401	0-16	7490AN	0-49	709	0-27				
7402	0-16	7491	0-65	710	0-28				
7403	0-16	7492	0-65	711	0-28				
7404	0-18	7493	0-45	NE555	0-60				
7405	0-18	7495	0-65	NE565	2-00*				
7406	0-18	7496	0-67	NE566	2-00*				
7409	0-18	7497	0-67	NE567	2-00*				
7410	0-16	7498	0-85	CA3045	3-00*				
7412	0-25	74100	1-07	CA3046	0-89*				
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7414	0-72	74121	0-34	MC1304P	1-66*				
7416	0-43	74122	0-40	MC1305P	1-66*				
7417	0-43	74123	0-60	MC1310P	1-66*				
7420	0-20	74141	0-80	MC1312P	1-66*				
7425	0-30	74145	0-58	MC1352P	0-75*				
7427	0-30	74150	1-20	MC1358P	0-75*				
7430	0-16	74154	0-93	MC1458P	0-77				
7432	0-30	74157	0-70	MC1496L	0-82*				
7437	0-80	74174	1-40	MC1496G	0-82*				
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7442	0-65	74180	0-66	SAS570	2-25				
7445	0-96	74181	1-80	AA200	1-95				
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7448	0-81	74192	0-70	TAA320	0-95				
7470	0-30	74193	1-35	TAA611B12*	2-25*				
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Transistors									
AC126	BC148	0-09*	BD137	0-48*	BFX87	0-29	OC84	0-40	2N3702
AC127	BC149	0-09*	BD138	0-48*	BFX88	0-29	OC139	0-60	2N3703
AC128	BC157	0-09*	BD139	0-58*	BFX89	0-99	OC140	1-39	2N3704
AC128K	BC158	0-09*	BD140	0-58*	BFY10	0-99	TIP29A	0-64*	2N3705
AC128K	BC159	0-09*	BD157	0-60	BFY18	0-59	TIP29A	0-64*	2N3706
AC141	BC167	0-09*	BD158	0-60	BFY50	0-40	TIP30	0-64*	2N3707
AC141K	BC168	0-09*	BD182	0-92	BFY51	0-40	TIP41A	0-54	2N3708
AC142	BC169	0-09*	BD183	0-92	BFY52	0-40	TIP42A	0-64*	2N3709
AC142K	BC169	0-12*	BD184	1-20	BFY51	0-18	TIP41A	0-68	2N3710
AC176	BC170	0-09*	BD233	0-68	BFY52	0-18	TIP42A	0-68	2N3711
AC176K	BC182	0-11*	BD233	0-48	BFY53	0-18	TIP47	0-80	2N3715
AC187	BC182L	0-11*	BD234	0-48	BFY90	2-00	TIP48	1-20	2N3716
AC187K	BC183	0-10*	BD238	0-60	BSW20	0-99	TIP49	1-20	2N3771
AC188	BC183L	0-11*	BD410	0-80	BSX19	0-16	TIP50	1-20	2N3772
AC188K	BC184	0-11*	BDX32	2-30	BSX20	0-18	TIP120	0-99	2N3773
AD140	BC184L	0-11*	BDY10	1-50	BSY27	0-39	TIP121	1-20	2N3819
AD161	BC185	0-20*	BDY11	2-00	BSY53	0-39	TIP122	1-20	2N3820
AD162	BC212	0-09*	BDY20	0-90	BSY54	0-39	TIP125	0-80	2N3823
AF115	BC207B	0-11*	BDY38	0-90	BSY55	0-74	TIP126	0-80	2N3866
AF116	BC208	0-09*	BDY60	1-79	BSY56	0-74	TIP127	0-80	2N3903
AF117	BC212L	0-11*	BDY61	1-95	BSY75	0-39	TIP130	0-80	2N3904
AF118	BC213	0-09*	BDY90	2-14	BSY76	0-39	TIP131	0-80	2N3905
AF124	BC213L	0-14*	BDY92	2-14	BSY77	0-39	TIP132	0-80	2N3906
AF125	BC214	0-09*	BF115	0-49	BSY78	0-39	TIP135	0-80	2N3925
AF126	BC214L	0-11*	BF179	0-30	BSY79	0-39	TIP136	0-80	2N3926
AF139	BC238	0-09*	BF180	0-39	BSY95A	0-18	TIP137	0-80	2N3927
AF239	BC300	0-34	BF181	0-39	BU105	3-95*	TIP140	1-20	2N3928
AL100	BC301	0-36	BF182	0-39	BU106	3-95*	TIP141	1-20	2N3929
AL102	BC302	0-49	BF183	0-39	BU126	1-60*	TIP142	1-20	2N3954
AU107	BC303	0-90	BF184	0-30	BU204	1-50*	TIP145	1-20	2N4058
AU110	BC307	0-15	BF185	0-29	BU204	1-50*	TIP146	1-20	2N4059
AU113	BC308	0-15	BF194	0-15	BU205	1-95*	TIP147	1-20	2N4060
BC107	BC317	0-09*	BF195	0-12*	BU206	2-45*	TIP150	1-20	2N4061
BC107B	BC318	0-13*	BF196	0-12*	BU207	2-45*	TIP151	1-20	2N4062
BC108	BC319	0-13*	BF197	0-12*	BU208	2-45*	TIP152	1-20	2N4284
BC108B	BC327	0-13*	BF200	0-49*	BU208A	2-45*	TIP2955	0-80	2N4285
BC109	BC328	0-13*	BF224	0-15*	BU406	1-50*	TIP3055	0-80	2N4286
BC109B	BC337	0-13*	BF244	0-15*	BU407	1-50*	TIP3439	1-20	2N4287
BC109C	BC338	0-13*	BF257	0-39	BU408	1-50*	TIP3440	1-20	2N4288
BC117	BC547	0-15*	BF258	0-39	BU426	1-50*	TIP3441	1-20	2N4289
BC118	BC548	0-15*	BF259	0-39	BU427	1-50*	TIP3442	1-20	2N4290
BC119	BC549	0-15*	BF337	0-39	BU428	1-50*	TIP3772	1-20	2N4291
BC120	BC550	0-15*	BF338	0-49	BU500	2-95*	TIP3773	1-20	2N4292
BC125	BC557	0-15*	BF339	0-49	BU501	2-95*	TIP3792	1-20	2N4293
BC126	BC558	0-15*	BF344	0-49	BU502	2-95*	TIP3794	1-20	2N4294
BC127	BC559	0-15*	BF345	0-49	BU503	2-95*	TIP3795	1-20	2N4295
BC128	BC560	0-15*	BF457	0-49	BU504	2-95*	TIP3796	1-20	2N4296
BC129	BC635	0-15*	BF458	0-49	BU505	2-95*	TIP3797	1-20	2N4297
BC130	BC636	0-15*	BF459	0-49	BU506	2-95*	TIP3798	1-20	2N4298
BC131	BC637	0-15*	BF469	0-49	BU507	2-95*	TIP3799	1-20	2N4299
BC132	BC638	0-15*	BF470	0-49	BU508	2-95*	TIP3800	1-20	2N4300
BC133	BC639	0-15*	BF471	0-49	BU509	2-95*	TIP3801	1-20	2N4301
BC134	BC640	0-15*	BF472	0-49	BU510	2-95*	TIP3802	1-20	2N4302
BC135	BC807	0-15*	BF473	0-49	BU511	2-95*	TIP3803	1-20	2N4303
BC136	BC808	0-15*	BF494	0-15	BU512	2-95*	TIP3804	1-20	2N4304
BC137	BC809	0-15*	BF495	0-15	BU513	2-95*	TIP3805	1-20	2N4305
BC138	BCY30	0-49*	BF496	0-15	BU514	2-95*	TIP3806	1-20	2N4306
BC139	BCY31	0-49*	BF597	0-29	BU515	2-95*	TIP3807	1-20	2N4307
BC140	BCY32	0-49*	BF598	0-29	BU516	2-95*	TIP3808	1-20	2N4308
BC141	BCY33	0-49*	BF599	0-29	BU517	2-95*	TIP3809	1-20	2N4309
BC142	BCY34	0-49*	BF600	0-29	BU518	2-95*	TIP3810	1-20	2N4310
BC143	BCY39	0-49*	BF613	0-29	BU519	2-95*	TIP3811	1-20	2N4311
BC147	BCY42	0-09*	BF614	0-29	BU520	2-95*	TIP3812	1-20	2N4312
BC148	BCY70	0-12*	BF615	0-29	BU521	2-95*	TIP3813	1-20	2N4313
BC149	BCY71	0-18*	BF616	0-29	BU522	2-95*	TIP3814	1-20	2N4314
BC157	BCY72	0-12*	BF617	0-29	BU523	2-95*	TIP3815	1-20	2N4315
BC158	BCZ11	0-39*	BF618	0-29	BU524	2-95*	TIP3816	1-20	2N4316
BC159	BD131	0-39*	BF619	0-29	BU525	2-95*	TIP3817	1-20	2N4317
BC160	BD132	0-39*	BF620	0-29	BU526	2-95*	TIP3818	1-20	2N4318
BC167	BD135	0-39*	BF621	0-29	BU527	2-95*	TIP3819	1-20	2N4319
BC168	BD136	0-39*	BF622	0-29	BU528	2-95*	TIP3820	1-20	2N4320
BC169	BD137	0-48*	BFX87	0-29	OC84	0-40	2N3702	0-10*	
BC170	BD138	0-48*	BFX88	0-29	OC139	0-60	2N3703	0-10*	
BC171	BD139	0-58*	BFX89	0-99	OC140	1-39	2N3704	0-10*	
BC182	BD140	0-58*	BFY10	0-99	TIP29A	0-64*	2N3705	0-10*	
BC183	BD157	0-60	BFY18	0-59	TIP29A	0-64*	2N3706	0-10*	
BC184	BD158	0-60	BFY50	0-40	TIP30	0-64*	2N3707	0-10*	
BC212	BD182	0-92	BFY51	0-40	TIP41A	0-54	2N3708	0-09*	
BC213	BD183	0-92	BFY52	0-40	TIP42A	0-64*	2N3709	0-09*	
BC214	BD184	1-20	BFY51	0-18	TIP41A	0-68	2N3710	0-09*	
BC237	BD233	0-68	BFY52	0-18	TIP42A	0-68	2N3711	0-10*	
BC238	BD233	0-48	BFY53	0-18	TIP47	0-80	2N3715	1-80	
BC239	BD234	0-48	BFY90	2-00	TIP48	1-20	2N3716	1-80	
BC250	BD238	0-60	BSW20	0-99	TIP49	1-20	2N3771	1-80	
BC251	BDX32	2-30	BSX19	0-16	TIP50	1-20	2N3772	1-90	
BC252	BDY10	1-50	BSX20	0-18	TIP120	0-99	2N3773	2-50	
BC253	BDY11	2-00	BSY27	0-39	TIP121	1-20	2N3819	0-25*	
BC258	BDY20	0-90	BSY53	0-39	TIP122	1-20	2N3820	0-50	
BC259	BDY38	0-90	BSY54	0-39	TIP125	0-80	2N3823	1-10	
BC267	BDY60	1-79	BSY55	0-74	TIP126	0-80	2N3866	1-29	
BC268	BDY61	1-95	BSY56	0-74	TIP127	0-80	2N3903	0-10*	
BC269	BDY90	2-14	BSY75	0-39	TIP130	0-80	2N3904	0-10*	
BC270	BDY92	2-14	BSY76	0-39	TIP131	0-80	2N3905	0-10*	
BC286	BF115	0-49	BSY77	0-39	TIP132	0-80	2N3906	0-10*	
BC287	BF179	0-30	BSY78	0-39	TIP135	0-80	2N3925	0-80	
BC288	BF180	0-39	BSY79	0-39	TIP136	0-80	2N3926	0-80	
BC297	BF181	0-39	BSY95A	0-18	TIP137	0-80	2N3927	0-80	
BC300	BF182	0-39	BU105	3-95*	TIP140	1-20	2N3928	0-80	
BC301	BF183	0-39	BU106	3-95*	TIP141	1-20	2N3929	0-80	
BC302	BF184	0-30	BU126	1-60*	TIP142	1-20	2N3954	0-80	
BC303	BF185	0-29	BU204	1-50*	TIP145	1-20	2N4058	0-09*	
BC307	BF194	0-15	BU204	1-50*	TIP146	1-20	2N4059	0-09*	
BC308	BF195	0-12*	BU205	1-95*	TIP147	1-20	2N4060	0-09*	
BC317	BF196	0-12*	BU206	2-45*	TIP150	1-20	2N4061	0-09*	
BC318	BF197	0-12*	BU207	2-45*	TIP151	1-20	2N4062	0-09*	
BC319	BF200	0-49*	BU208	2-45*	TIP152	1-20	2N4284	0-12*	
BC327	BF224	0-15*	BU208A	2-45*	TIP2955	0-80	2N4285	0-12*	
BC328	BF244	0-15*	BU406	1-50*	TIP3055	0-80	2N4286	0-12*	
BC337	BF257	0-39	BU407	1-50*	TIP3439	1-20	2N4287	0-12*	
BC338	BF258	0-39	BU408	1-50*	TIP3440	1-20	2N4288	0-12*	
BC347	BF259	0-39	BU426	1-50*	TIP3441	1-20	2N4289	0-12*	
BC348	BF337	0-39	BU427	1-50*	TIP3442	1-20	2N4290	0-12*	
BC349	BF338	0-49	BU428	1-50*	TIP3772	1-20	2N4291	0-12*	
BC350	BF339	0-49	BU500	2-95*	TIP3773	1-20	2N4292	0-12*	
BC351	BF344	0-49	BU501	2-95*	TIP3792	1-20	2N4293	0-12*	
BC352	BF345	0-49	BU502	2-95*	TIP3794	1-20	2N4294	0-12*	
BC353	BF457	0-49	BU503	2-95*	TIP3795	1-20	2N4295	0-12*	
BC354	BF458	0-49	BU504	2-95*	TIP3796	1-20	2N4296	0-12*	
BC355	BF459	0-49	BU505	2-95*	TIP3797	1-20	2N4297	0-12*	
BC360	BF469	0-49	BU506	2-95*	TIP3798	1-20	2N4298	0-12*	
BC361	BF470	0-49	BU507	2-95*	TIP3799	1-20	2N4299	0-12*	
BC362	BF471	0-49	BU508	2-95*	TIP3800	1-20	2N4300	0-12*	
BC363	BF472	0-49	BU509	2-95*	TIP3801	1-20	2N4301	0-12*	
BC364	BF473	0-49	BU510	2-95*	TIP3802	1-20	2N4302	0-12*	
BC365	BF494	0-15	BU511	2-95*	TIP3803	1-20	2N4303	0-12*	
BC366	BF495	0-15	BU512	2-95*	TIP3804	1-20	2N4304	0-12*	
BC367	BF496	0-15	BU513	2-95*	TIP3805	1-20	2N4305	0-12*	
BC368	BF597	0-29	BU514	2-95*	TIP3806	1-20	2N4306	0-12*	
BC369	BF598	0-29	BU515	2-95*	TIP3807	1-20	2N4307	0-12*	
BC370	BF599	0-29	BU516	2-95*	TIP3808	1-20	2N4308	0-12*	
BC371	BF600	0-29	BU517	2-95*	TIP3809	1-20	2N4309	0-12*	
BC372	BF613	0-29	BU518	2-95*	TIP3810	1-20	2N4310	0-12*	
BC373	BF614	0-29	BU519	2-95*	TIP3811	1-20	2N4311	0-12*	
BC374	BF615	0-29	BU520	2-95*	TIP3812	1-20	2N4312	0-12*	
BC375	BF616	0-29	BU521	2-95*	TIP3813	1-20	2N4313	0-12*	
BC376	BF617	0-29	BU522	2-95*	TIP3814	1-20	2N4314	0-12*	
BC377	BF618	0-29	BU523	2-95*	TIP3815	1-20	2N4315	0-12*	
BC378	BF619	0-29	BU524	2-95*	TIP3816	1-20	2N4316	0-12*	
BC379	BF620	0-29	BU525	2-95*	TIP3817	1-20	2N4317	0-12*	
BC380	BF621	0-29	BU526	2-95*	TIP3818	1-20	2N4318	0-12*	
BC381	BF622	0-29	BU527	2-95*	TIP3819	1-20	2N4319	0-12*	
BC382	BFX87	0-29	BU528	2-95*	TIP3820	1-20	2N4320	0-12*	

MEMORIES

2102A-4	3-99
2112A-4	4-75
2102	2-99
2102	2-99
2102	2-99
2102	2-99

TO3 NPN 20 amp Triple-tons similar to 2N3771/2/3

Untested but no shorts or opens

5 Pcs	2-99
10 Pcs	5-00
25 Pcs	7-50

CMOS PLASTIC

4000BE	0-20	
4001BE	0-20	
4002BE	0-20	
4006BE	0-80	
4007BE	0-20	
4008BE	0-80	
4009BE	0-40	
4010BE	0-40	
4011BE	0-20	
4012BE	0-20	
4013BE	0-50	
4015BE	0-95	
4016BE	0-50	
4017BE	0-54	
4018BE	0-90	
4019BE	0-50	
4020BE	1-03	
4021BE	1-03	
4022BE	0-95	
4023BE	0-20	
4024BE	0-62	
4025BE	0-20	
4026BE	1-32	
4027BE	0-50	
4028BE	0-80	
4029BE	0-90	
4030BE	0-50	
4031BE	2-50	
4032BE	0-90	
4033BE	1-50	
4034BE	1-32	
4035BE	0-95	
4036BE	2-50	
4037BE	0-90	
4038BE	0-90	
4039BE	2-50	
4040BE	0-90	
4041BE	0-90	
4042BE	0-62	
4043BE	0-90	
4044BE	0-62	
4045BE	1-32	
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enthusiasts and it is a pleasant duty to thank Mr. and Mrs. Owen of Dollgellan who took the trouble to take these speakers and other components to Bedford.

J. Hilditch of Nantwich has sent the basic brass tacks letter asking "how do I start DXing"? The answer to this is in two parts. The first is decide which sort of DXing takes your fancy, Latin American, North American, Asian, etc. Then, secondly, the thing to do is to decide which of the technical aspects of DXing interests you, aerials, receivers or perhaps it might be propagation. Having decided we can then move on to study these. This can be done by getting hold of a good set of leaflets on your chosen themes. Many stations offer these, generally free of charge, or at worst for the cost of return postage or a few IRCs. The best I know are distributed by Radio Nederland, PO Box 222, Hilversum, Holland, and are free. These leaflets will lead you on to thinking and planning your DX rather than random listening and hoping to catch that elusive station. After all, a fisherman who goes for a particular fish arranges his tackle to suit. It is no good trying for a special station when the darkness path does not suit or your aerial is all wrong!

Some DXers concentrate on collecting QSL cards and in order to do this a knowledge of how to write a letter in a foreign tongue may help and this perhaps will lead to a visit to a reference library. So it can be seen that every aspect of our hobby has a spin-off into some other activity.

With that I fear that I must close down and thank you all for your support and to the readers in all the overseas countries that took the trouble to write, I wish you good DX and best 73s to you and yours.

Reports on SW BC bands should now be sent to Charles Molloy, see box for details.

VHF BANDS

by Ron Ham BRS15744

Members of the Brighton And District Radio Society were sporting their Jubilee callsigns at the Peacehaven Carnival on June 6th where they gave the visitors an insight to amateur radio. Their 2m station, an FT221 and a 10-element Sky-Beam, installed on the balcony of the Youth Centre was operated periodically by Brian Fenwick GE8BTC, Nigel Hewitt GE8JFT and Alan Baker, GE8LGQ. The Sky-Beam, mounted on a 15ft mast above the balcony, had a mechanical rotator and an electronic beam-heading indicator.

Among the stations worked during the afternoon were F1DZP and a YL operator F1CSW. The group used their own PA system so that visitors could hear the VHF traffic, which took on a special interest when Alan left the station to give a mobile demonstration. A specially prepared leaflet about amateur radio, listing four local clubs, was given to interested people.

During the early hours of the 4th, GE8LGQ took advantage of a lift and worked PE, ON and F on 2m SSB and at 0330 he contacted GE8DJR the station installed at Windsor Castle. Alan worked 36 stations on 2m and the last one was F6DGU/MM operating a hand-held set on board the Newhaven Ferry 'Vilandry'.

The major sporadic-E disturbances of the 1977 season began on May 25 when strong signals from east-European FM broadcast stations were received between 65 and 73MHz on a dipole feeding my R216 receiver. Similar events, lasting a few hours occurred on May 27 and periodically each day from June 8 to 15th inc., and each time strong vision pulses on Ch.R1 (49·75MHz), warned of the forthcoming event. The frequency range 40 to 75MHz was open all day on the 9th reaching a climax around 1800 when I counted 42 east-European broadcast signals between 65 and 73MHz. However, the most intense disturbance so far occurred around 1800 on the 14th when I heard 46 of these broadcast stations, and for about an hour the sporadic-E extended it's influence to 2m giving G4FUT, G8LIC and G8LZM the opportunity to work YU, YO, HB, LZ and I0SVS in Rome. Sporadic-E upset Band II during the evening of the 7th and 8th, according to **Ken Smith** BRS20001 Horsham, who heard several continental FM signals between 95 and 100MHz. Ken's report was soon followed by a postcard from "dampest Devon" where **John Wilson** G8KIS and **Richard Lambley** G8LAM were on holiday with their families. Richard wrote "We were listening to North Hessary Tor (R4) on my Beolit 600 portable about 1700GMT when the set started being 'captured' by German speaking stations. The whole band was alive with Austrian, Italian and Yugoslav stations until 1800 when it went flat again; all at ground level with a whip aerial and heavy local screening".

Almost every day from May 26th to June 19th there was activity on 10m. **Nigel Golds** BRS36910 West Chiltington, Sussex heard South-American stations on the 5th in addition to the short skip signals from Scandinavia to Africa which were predominant on most days. Like many of us, Nigel looked first for the International Beacon Project stations hearing 5B4CY on June 1st and 2nd and strong signals from DL0IGI for some period every day. **Alan Baker** G8LGQ Newhaven, heard the German beacon around midnight on several occasions and on the 8th he just heard the Canadian beacon VE3TEN.

To add to the fun, the sun went "active" on the 4th, **Cmdr. Henry Hatfield,** Sevenoaks, using his spectroheliioscope, found a sunspot group in the northern hemisphere, a bright plage in the southern hemisphere and a spray of gas on the east limb. Although overcast skies hampered visual observation, **Robert Mackenzie,** Dover, who projects the sun's image through his telescope, saw the sunspot group on the 8th. **John Smith,** Cranleigh, reported a marked increase in solar radio noise at 142MHz on the 5th and G8LGQ heard the "seashore" sound on both 2m and 10m indicating the wide frequency coverage of some of the solar bursts.

Both Henry and myself recorded several bursts and a mild solar noise storm at 136MHz on June 5th, 7th, 8th and 9th and the largest individual burst occurred on the 9th and lasted for six minutes. I hope to have reports soon from **Kelvin Lake,** Edgbaston, Birmingham, who, with the aid of a friend, has just completed a corner reflector interferometer, with a 25 wavelength baseline, operating at 143MHz, for radio astronomy work.

The prevailing high atmospheric pressure, 30·4″ began to fall on June 2nd and 3rd causing a tropo-opening toward the north; during this period I received a 569 signal from GB3SUT 432·890MHz, a picture from Lichfield on 189MHz, and several con-

tinental FM stations in Band II with a dipole feeding the receivers in each case. Another tropo-opening began during the evening of the 16th and **Barry Ainsworth** G8HYN Sompting, Sussex, worked PA0's, F's and GU4EON/M on 2m SSB and at 2330 he contacted G8HVY in Weymouth on 70cms. At the same time, I heard 8 continental FM stations in Band II and a PA0 working EI on 2m. GB5SUT came up at 2130 and was frequently heard in Sussex until the small hours of the 20th. During the afternoon of the 19th G8LGQ had a contact with G2BAR in Bristol and at 1816 he worked GW4FPX/P in Gwent. As if these were not enough to satisfy a VHF man's ego for one day, Alan heard a very weak GM pop up from the noise around 2000 and he stuck on that frequency until 2315 when, for the first time from his home in Newhaven, he worked GM6UW/P just north of Aberdeen, a distance of 560 miles which is not bad going on 2m!

Owing to the prevailing sporadic-E disturbance to the 4m band I was unable to make a satisfactory observation of the June Lyrid meteor shower which reached it's peak on the 15th. However, the next event to look out for are the Perseids which reach their maximum on August 12th. I would also like to remind you all about the 4m Open Contest on August 13th/14th and the 2m Open Contest on September 3rd/4th and in both events SWLs are welcome to take part.

Ivan Davies G3IZD took advantage of the good conditions and worked OZ1OQ and ON6AG on 2m SSB, from Arundel, Sussex during the evening mobile rally organised by Worthing and District ARC on June 21st. Among the visitors to the rally was Ernie Hoare G8BDJ from Brighton who learned recently that he was the winner of the 3cm section of the IARU Region 1 contest held last October. Ernie told me that he hopes to get going on 24GHz soon.

Thanks again to all of you who send me reports, I really do look forward to hearing from you and putting this feature together.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

Amateur Bands—continued

You won't be able to make the next meeting of the Wessex AR Group, on 5 August, because it's too late! But because it will be a very interesting talk perhaps G6MB and G4AMW might consider repeating it, if you ask them nicely! Title is 'Problems encountered in building and operating HF transceivers using the SL600 IC's. You will be able to make the following date on 19 August when Power Supply Units will be discussed followed by a talk on studying for the RAE. Details from Geoff Cole G4EMN, 6 St. Anthonys Road, Bournemouth (Tel: 20027).

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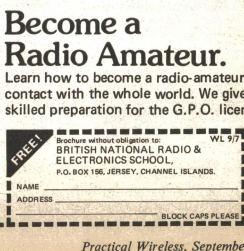

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1D5	1-00	6AW6	.64	6QR7	.70	9U11	.70	20P4	.70		
1G6GT	1-00	6AX4	.75	6H6GT	.90	10C12	.60	20D4	2-00		
1R5GT	-65	6BA6	.70	6J5	.60	10C1	.60	20L1	.80		
1L4	-65	6BA8	.60	6J6	.65	10D2	.60	20L1	1-00		
1L5G	-65	6BE6	.60	6J7G	.70	10F1	1-00	20P1	1-00		
1LN5	.70	6BE6	.60	6J7M	.65	10F9	.65	20P3	1-00		
1N5GT	.75	6BG6G	1-50	6J7GT	.65	10P13	.70	20P9	1-00		
1S5	-60	6BH6	.70	6K7G	.65	10L14	.65	20P5	1-00		
1S4	-65	6BJ6A	.60	6K8G	.75	10LD3	.65	20P9	1-00		
1S5	-65	6BK7A	.65	6K8GT	.65	10LD13	.65	20L6G	.70		
1T4	-60	6BN6	1-00	6K8M	.65	10LD20	.65	20L6	.70		
1U4	.70	6BQ5	.65	6L6GC	.85	10P13	.65	20T6G	.65		
1U5	.70	6BR7	.65	6L7	.65	10P14	.70	20T6	.65		
2D21	-65	6BR7	1-00	6L6	.85	12A5	.65	20Z5	.70		
5U4G	.75	6BZ6	1-00	6L6G	.85	12A6	.65	20Z6G	.70		
5X3	.70	6BZ7	2-00	6L19	2-00	12AD6	.60	20Z7	2-00		
5Y3	.60	6BW6	1-70	6L20	2-00	12AE6	.60	20A5	.75		
5Y3	-65	6BW7	.65	6LD20	.65	12AT6	.64	20C1	.65		
5Y4G	.60	6C4	.60	6P1	.65	12AT7	.75	20C1	.65		
5Z4	.60	6BT7	.80	6P9	.65	12AU6	.64	20C1	.65		
5Z4GT	.60	6BT7	.80	6P13	.65	12AU7	.75	20C1	.65		
6B4	.60	6C4	.60	6Q7G	.60	12AV6	.64	20C1	.65		
6B8	.70	6C6	.60	6Q7GT	.60	12AX7	.64	20C1	.65		
6C8G	.75	6C8	.80	6Q7GM	.60	12AY7	.64	20C1	.65		
6C9	.70	6C9	2-00	6R7G	.60	12BA6	.60	20C1	.65		
6C10	.70	6C10	.70	6R7GT	.60	12BE6	.60	20C1	.65		
6C6G	1-00	6C8GA	.60	6S7GT	.75	12BH7	.65	20C1	.65		
6F6	.60	6C8G	.60	6S8GT	.75	12BR7	.65	20C1	.65		
6F6A	1-00	6CD6G	1-00	6SH7	.65	13D1	2-00	20C1	.65		
6F6G	.60	6CH6	.60	6SJ7	.65	13D2	2-00	20C1	.65		
6F6GT	.60	6CL6	.75	6SK7GT	.65	13T7GT	.70	20C1	.65		
6F8	.65	6CM6	1-00	6SL7	.65	13T8GT	.70	20C1	.65		
6F8G	.65	6CM7	1-00	6U4GT	.65	15CW5	.70	20C1	.65		
6F8GT	.65	6CM8	.65	6U7G	.65	15CW8	.70	20C1	.65		
6J8G1	.70	6CU5	.90	6U8	.65	19Q2GT	.60	20C1	.65		
6A8G	1-00	6CU6	.60	6V6G	.60	19AE3	.70	20C1	.65		
6AC7	.65	6D3T	.90	6V6GT	1-00	19AQ5	.70	20C1	.65		
6AC7	.65	6D6G	.60	6V6M	.65	19BG6G	.80	20C1	.65		
6AG7	.60	6EW6	.65	6X5GT	.65	19H1	1-00	20C1	.65		
6AH6	.60	6F1	.65	6X8G	.65	19J6	.70	20C1	.65		
6AJ8	.70	6F2	.60	6Y7G	1-65	19K7	.60	20C1	.65		
6AK5	.65	6F12	.60	6Y7M	.65	19K8	.60	20C1	.65		
6AK5	.65	6F13	.60	7A6	.60	19T8	.78	35Z4GT	.70		
6AK5	.65	6F15	.60	7B6	.60	19TY4	.70	35Z5GT	.70		
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DK32	-60	ECC83	-64	EM84	-65	LN309	-65			U26 1-00	AC170 -44	HF212 -60
DK91	-60	ECC84	-64	EM85	-65	LN319	1-00	PL504/90	-90	U35 1-70	AC177 -60	HF213 -60
DK92	-60	ECC85	-64	EM87	1-00	MH4	1-00	PL508 1-00		U37 -60	AC178 -60	HF214 -60
DK96	-60	ECC86	1-00	EM88	1-00	MH4D	1-00	PL509 2-00		U81 -60	AC718 -23	HF241A 1-00
DL33	-60	ECC88	1-00	EM89	1-00	ML6	1-00	PL519 1-00		U191 -60	AC719 -23	HF242 -60
DL35	-60	ECF1	-85	EM91	-85	MS4B	1-00	PY80	-60	U281 1-00	ACT20 -30	OA47 -18
DL63	-70	ECH3	-58			MS/PEN	3-00	PY81	-60	U301 1-00	ACT22 -30	OA70 -18
DL64	-70	ECH4	1-00	EY51	-65	MXT4	1-00	PY82	-60	U403 -60	ACT23 -18	OA79 -18
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DL94	-60	ECH35	-65	ECH81	-70	EY91	-65	PY88	-65	U801 -60	AD140 -60	OA85 -11
DL95	-60	ECH42	-65	ECH83	-70	EY500A	-75	PY500	-85	U4020 -60	AD149 -60	OA90 -11
DL96	-60	ECL80	-70	ECL82	-70	EZ40	-60	PY500A	-85	UF28 -65	AD162 -53	OA95 -60
DM70	-60	ECL82	-70	ECL83	-70	EZ41	-60	PY500A1	-85	UF41 -60	AF100 -60	OA200 -11
DM71	-60	ECL86	-70	ECL85	-70	EZ80	-60	PY800	-60	UF42 -60	AF114 -60	OA202 -11
DW2	-60	EF36	-65	ECL86	-70	EZ81	-60	PY801	-60	UF80 -60	AF115 -60	OA210 -11
DW4	-60	EF37A	-65	ECL86	-70	EZ90	-60	PY802	-60	UF85 -60	AF116 -60	OA211 -11
DY86	-60	EF39	-65	ECL86	-70	EZ91	-60	PY803	-60	UF89 -60	AF117 -60	OA212 -11
DY87	-60	EF40	-65	ECL86	-70	EZ92	-60	PY804	-60	UF92 -60	AF118 -60	OA214 -11
DY802	-60	EF41	-65	ECL86	-70	EZ93	-60	PY81/90	-60	UF93 -60	AF121 -60	OA215 -11
E88C	-60	EF42	-65	ECL86	-70	EZ94	-60	PY82/90	-60	UF94 -60	AF124 -60	OA216 -11
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E88CC	-60	EF50	-65	ECL86	-70	EZ96	-60	PY88/90	-60	UF96 -60	AF126 -60	OA218 -11
E90CC	-70	EF50	-65	ECL86	-70	EZ97	-60	PY500/90	-90	UF97 -60	AF127 -60	OA219 -11
E90CC	-70	EF50	-65	ECL86	-70	EZ98	-60	PY500A/90	-90	UF98 -60	AF128 -60	OA220 -11
E90CC	-70	EF50	-65	ECL86	-70	EZ99	-60	PY801/90	-60	UF183 -60	AF129 -60	OA221 -11
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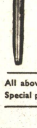

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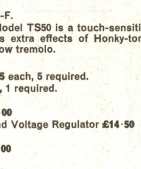

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ECC81 0-88 EY86/87 0-89 PCL805/ UCH81 1-24
ECF80 0-88 EZ35 0-88 850 0-89 UCL83 OFF
ECF82 0-88 EZ40 0-88 PD500 0-98 UF41 1-32
ECH35 OFF GY501 1-32 PL200 OFF UY85 0-80
ECH42 1-90 GZ32 1-84 PL81 1-08 Z77 1-08
ECH81 OFF KT33C 0-88 PL81A 1-08 ECC91OFF
ECH83 OFF OC3 0-88 PL82 1-08 6F8G/EF91 1-32
ECL80 0-88 PC86 1-08 PL83 1-08 PCL800 1-44
ECL82 0-72 PC88 0-88 PL84 0-88 30C1/PCF80 0-72
ECL83 OFF PC92 0-82 PL500 0-98 30C15/
ECL86 0-84 PC900 0-82 PL504 0-96 PCF801 1-58
EF80 0-84 PCC84 0-88 PL508 1-32 30P1/L15 1-44

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AZ31 1-84
CBL31 1-58
CL33 1-90
CY31 1-90
DAF91 1-90
DAF96 1-90
DCC90 1-90
DF91 0-48
DF96 1-90
DK91 0-98
DK92 1-35
DK96 1-18
DL35 ELSM-DH/SUP
DL94 3-99
DY86 0-84
DY87 0-84
DY802 0-98
EABC80 0-84
EAF42 1-35
EB91 0-84
EBC33 1-78
EBC41 1-84
EBC81 1-18
EBF80 0-84
EBF83 1-25
EBF89 0-98
EBL31 2-99
EC52 0-98
EC92 0-85
EC93 0-84
EC94 0-90
EC95 0-90
EC96 0-98
ECC81 0-84
ECC82 0-84
ECC83 0-84
ECC84 0-90
ECC85 0-90
ECC86 0-98
ECC88 0-98
ECF80 0-84
ECF82 0-84
ECH35 0-98
ECH42 1-90
ECH81 0-84
ECH83 0-98
ECL80 0-90
ECL82 0-84
ECL83 1-90
ECL86 0-84
EF37A 1-90
EF39 0-84
EF50 0-65
EF80 0-84
EF85 0-84
EF86 USSR 0-48

EF89 Mullard
EF91 0-84
EF92 0-98
EF93 0-75
EF94 0-75
EF95 UK 1-65
EF96 1-90
EF183 0-90
EF184 0-90
EL32 1-90
EL33 OFF
EL34 0-85
EL34-CH/S(LOP
VACK 1-90
EL41 0-84
EL37 3-99
EL42 0-84
EL43 1-75
EL44 1-75
EL45 0-84
EL46 0-84
EL84 0-90
EL90 0-84
EM80 0-84
EM81 1-25
EM84 0-84
EM85 1-25
EV51 0-75
EY51 0-75
EY86 0-84
EY87 0-84
EY88 0-84
EZ40 1-25
EZ80 0-85
EZ81 0-85
FW4/500 1-90
GY501 1-32
GZ30 0-75
GZ32 0-75
HN309 2-00
KT61 1-84
KT66 2-00
KTW61/CR 1-84
KT88 4-75
KTW61 1-78
MU14 1-00
N78 7-00
OA2 0-45
OB2 0-45
PC86 0-85
PC88 0-85
PC92 0-82
PC97 0-88
PC900 0-75
PCC84 0-45
PCC85 0-85
PCC88 1-65
PCF80 1-05
PCF82 1-05
PCF86 1-65
PCF200 1-77
PCF801 1-65
PCF802 1-65
PCF805 1-77
PCF806 1-77
PCF808 OFF
PCH200 OFF
PCL82 0-88
PCL83 1-05
PCL84 0-79
PCL85 1-16
PCL86 0-88
PCL805/ 850 0-89
PD500 0-98
PEN45 1-29
PL36 0-85
PL81 1-08
PL82 1-08
PL83 1-08
PL84 0-88
PL500 0-98
PL504 0-96
PL508 1-32
PL509 OFF
PL802 1-65
PY31/500 0-72
PY81 0-72
PY82 0-85
PY88 0-98
PY500A 1-50
PY800/801 0-72
PY801 0-72
U14 0-85
U18 0-85
U191 OFF
U251 1-10
UABC80 0-90
UAF42 1-35
UBC41 0-84
UBF80 0-84
UBF89 0-98
UCC85 1-16
UCF80 1-24
UCH42 1-84
UCH81 0-84
UCL82 0-90
UCL83 1-90
UF41 1-32
UF42 1-32
UF80 0-84
UF85 0-84
UL41 0-75
UL84 0-90
UM80 0-84
UM84 0-84
UY41 0-75
UY85 0-80
VR150/30 0-48
VR150/30 0-84
1R5 0-85
1S5 0-85
1T4 0-48
1U4 0-85
3V4 1-00
5U4G 0-85
5U4G 1-00
5V4G 0-85
5Y3GT 0-85
6X4 0-85
6X5G 1-00
6Z4G 1-00
6X5GT 0-85
7B5 1-00
7B7 1-00
7C5 1-00
7C6 1-25
7H7 1-00
7R7 1-84
7S7 1-90
7Y4 0-75
9D2 0-75
10C1 0-72
10F1 0-72
10F9 0-72
12AT6 0-85
12AT7 0-85
12AU6 0-85
12AU7 0-85
12BA6 0-85
12BE6 0-85
12BH7 0-85
12K7GT 0-85
12Q7GT 0-85
20P1 1-58
20P3 1-58
20P4 1-58
30P4MR OFF
30PL1 1-44
30PL12 1-44
30PL13 1-44
30PL14 1-68
30PL15 1-44
30PL16 1-44
30C17 1-90
30C18 2-16
30C1/PCF805 1-28
30FL2/6116 1-90
30FL14/ PCL805 1-90
30FL2 1-90
30FL12 1-90
30P12 0-72
30P19 0-72
30PL1/ PCL82 0-72
30PL13/ PCL85 1-44
30PL14 1-68
30PL15 1-44
30PL16 1-44
30PL1/PCL86 1-44
30PL14/PCL805 1-32
30PL15/ PCL85 1-68
30PL16 1-44
30PL15 1-44

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AA119 0-35
AAY30 0-12
AAY32 0-15
AAZ15 0-35
AAZ16 0-35
AAZ17 0-35
AC107 0-75
AC113 0-75
AC125 0-55
AC126 0-55
AC128 0-55
AC141 0-56
AC141K 0-90
AC142 0-60
AC142K 0-95
AC151 0-60
AC187 0-55
AC188 0-55
ACY17 0-65
ACY18 0-65
ACY19 0-65
ACY20 0-65
ACY21 0-65
ACY22 0-65
AD140 0-85
AD161 0-75
AD162 0-75
AD163 0-75
AF106 0-65
AF114 0-55
AF115 0-55
AF116 0-55
AF117 0-55
AF139 0-90
AF186 1-50
AF239 0-90
AFZ11 0-78
AFZ12 0-75
ASY26 0-45
ASY27 0-45
ASZ15 1-25
ASZ16 1-25
ASZ17 1-25
AU106 0-95
AU107 0-85
AU110 0-90
AU111 0-90
AU112 0-90
AU113 0-90
AUY10 0-85
AUY21 0-85
BA145 0-15
BA148 0-15
BA155 0-15
BA156 0-15
BAW62 0-15
BAX13 0-07
BAX16 0-12
BC107 0-12
BC108 0-12
BC109 0-13
*BC113 0-15
*BC114 0-15
*BC115 0-15
*BC116 0-19
*BC117 0-19
*BC118 0-16
*BC119 0-20
*BC120 0-25
*BC121 0-20
*BC122 0-20
*BC123 0-20
*BC124 0-20
*BC125 0-20
*BC126 0-20
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*BC129 0-18
*BC130 0-19
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*BC172 0-14
*BC173 0-14
BC177 0-18
BC178 0-18
BC179 0-18
*BC182 0-11
*BC183 0-11
*BC184 0-11
*BC186 0-11
*BC187 0-11
*BC214 0-17
*BC237 0-15
*BC238 0-15
*BC239 0-15
BC300 0-99
BC301 0-99
*BC302 0-99
*BC303 0-99
*BC306 0-18
*BC307 0-18
BSW4 0-99
*BC308 0-18
*BC309 0-18
BC327 0-19
BC328 0-19
BC337 0-19
BC338 0-19
BCY30 1-60
BCY31 1-60
BCY32 1-60
BCY33 1-60
BCY34 1-60
BCY38 3-90
BCY39 3-90
BCY40 2-50
BCY42 0-18
BCY43 0-18
BCY70 0-18
BCY71 0-22
BCY72 0-17
BCZ11 1-50
BD115 0-90
BD121 0-90
BD123 1-90
BD124 1-60
BD131 0-84
BD132 0-84
*BD135 0-38
*BD136 0-38
*BD137 0-38
*BD138 0-38
*BD140 0-47
BD144 0-90
BD181 1-38
BD182 1-50
BD237 0-90
BD238 0-90
BDX10 0-75
BDX32 0-90
BDY20 1-42
BDY38 1-90
BF115 0-90
BF152 0-90
BF153 0-25
BF154 0-25
BF159 0-25
BF160 0-25
BF167 0-39
BF173 0-39
BF177 0-39
BF178 0-45
BF179 0-45
BF180 0-45
BF181 0-45
BF182 0-45
BF183 0-45
BF184 0-45
BF185 0-45
*BF194 0-12
*BF195 0-13
*BF196 0-13
*BF197 0-13
BF200 0-52
*BF224 0-25
*BF244 0-25
BF257 0-37
BF258 0-42
BF259 0-50
*BF336 0-50
*BF337 0-53
*BF338 0-55
BF361 1-38
BF529 1-38
*BF569 0-25
*BF598 0-25
BFW10 0-90
BFW11 0-90
BFW12 0-90
BFX85 0-61
BFX87 0-61
BFX88 0-32
BFY50 0-32
BFY51 0-32
BFY52 0-32
BFY90 0-32
BAX13 0-07
BAX16 0-12
BC107 0-12
BC108 0-12
BC109 0-13
*BC113 0-15
*BC114 0-15
*BC115 0-15
*BC116 0-19
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*BC118 0-16
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*BC120 0-25
*BC121 0-20
*BC122 0-20
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*BC184 0-11
*BC186 0-11
*BC187 0-11
*BC214 0-17
*BC237 0-15
*BC238 0-15
*BC239 0-15
BC300 0-99
BC301 0-99
*BC302 0-99
*BC303 0-99
*BC306 0-18
*BC307 0-18
BSW4 0-99
*BC308 0-18
*BC309 0-18
BC327 0-19
BC328 0-19
BC337 0-19
BC338 0-19
BCY30 1-60
BCY31 1-60
BCY32 1-60
BCY33 1-60
BCY34 1-60
BCY38 3-90
BCY39 3-90
BCY40 2-50
BCY42 0-18
BCY43 0-18
BCY70 0-18
BCY71 0-22
BCY72 0-17
BCZ11 1-50
BD115 0-90
BD121 0-90
BD123 1-90
BD124 1-60
BD131 0-84
BD132 0-84
*BD135 0-38
*BD136 0-38
*BD137 0-38
*BD138 0-38
*BD140 0-47
BD144 0-90
OC24 3-99
OC25 3-99
OC26 2-99
OC28 2-99
OC29 3-99
OC35 2-99
OC36 2-99
OC41 0-45
OC42 0-90
OC43 0-90
OC44 0-39
OC45 0-39
OC71 0-45
OC72 0-45
OC73 1-90
OC74 0-90
OC75 0-90
OC76 0-90
OC77 1-39
OC81 0-45
OC81Z 1-90
OC82 0-90
OC83 0-90
OC84 0-90
OC122 1-90
OC123 1-90
OC139 1-25
OC140 1-25
OC169 1-25
OC170 0-90
OC171 1-90
OC200 1-90
OC201 1-90
OC202 1-25
OC203 1-25
OC204 1-25
OC205 1-25
OC206 1-75
OCP71 1-25
OCP72 2-25
*R2006B 2-25
*R2006S 2-25
*R2010B 2-25
*R2010S 2-25
TIC206D 1-39
TIC206D 1-39
TIL309 0-90
*TIP29A 0-90
TIP30A 0-90
*TIP31A 0-62
*TIP32A 0-62
*TIP33A 1-99
*TIP34A 1-99
TIP41A 0-79
*TIP42A 0-79
SN141 0-85
SN142 0-85
SN143 0-85
SN144 0-85
SN145 1-00
SN146 1-00
SN147 1-00
SN148 1-00
SN149 1-00
SN150 1-00
SN151 0-85
SN152 0-85
7400 0-39
7401 0-39
7402 0-39
7403 0-39
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7408 0-39
7409 0-39
7410 0-39
7411 0-39
7412 0-39
7413 0-39
7414 0-49
7416 0-49
7417 0-49
7420 0-39
7423 0-39
7425 0-39
7426 0-39
7427 0-39
7430 0-39
7432 0-39
7433 0-39
7437 0-42
7438 0-42
7440 0-39
7441AN 0-82
7442 0-78
7447AN 0-99
7450 0-39
7451 0-39
7453 0-39
7460 0-39
7470 0-42
7472 0-39
7473 0-39
7474 0-49
7475 0-49
7476 0-42
7480 0-78
7482 0-89
7483 0-89
7484 1-00
7485 1-00
7486 0-82
7489 1-99
7490 0-89
7491AN 0-89
7492 0-89
7493 0-89
7494 0-89
7495 0-89
7496 0-89
7497 1-99
74100 1-79
74107 0-89
74109 0-89
74110 0-57
74111 0-89
74116 0-89
74118 0-89
74119 0-89
74141 0-89
74121 0-45
74122 0-89
74123 1-99
74125 0-89
74126 0-89
74132 0-89
74136 0-89
74141 0-89
74142 0-89
74143 0-89
74144 0-89
74145 1-00
74147 1-99
74148 2-00
74150 1-99
74151 0-89
74153 0-89
74154 1-99
74155 0-89
74156 0-89
74157 0-89
74158 0-89
74170 0-89
74172 0-89
74173 0-89
74174 0-89
74175 0-89
74176 0-89
74177 0-89
74178 0-89
74179 0-89
74180 0-89
74181 1-99
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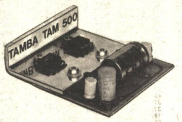

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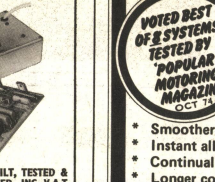

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WATFORD ELECTRONICS

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TYPE	U4312	U4313	U4315
Sensitivity D.C.	667 o.p.v.	20,000 o.p.v.	20,000 o.p.v.
Sensitivity A.C.	667 o.p.v.	2,000 o.p.v.	2,000 o.p.v.
D.C. Current	300 μA-6A	50μA-2·5A	50μA-2·5A
A.C. Current	1·5mA-6A	0·6mA-1·5A	0·5mA-2·5A
D.C. Volts	75mV-600V	75mV-600V	75mV-1000V
A.C. Volts	300mV-600V	15V-600V	1V-1000V
Resistance	0·02-3kΩ	1K-1M	300Ω-500kΩ
Capacity	—	0·5μF	0·5μF
Accuracy	1½ D.C., 1·5% A.C.	1·5% D.C., 2·5% A.C.	2·5% D.C., 4% A.C.

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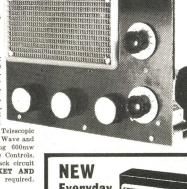

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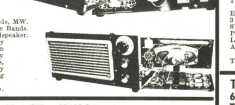

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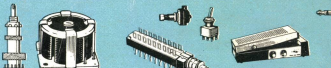

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